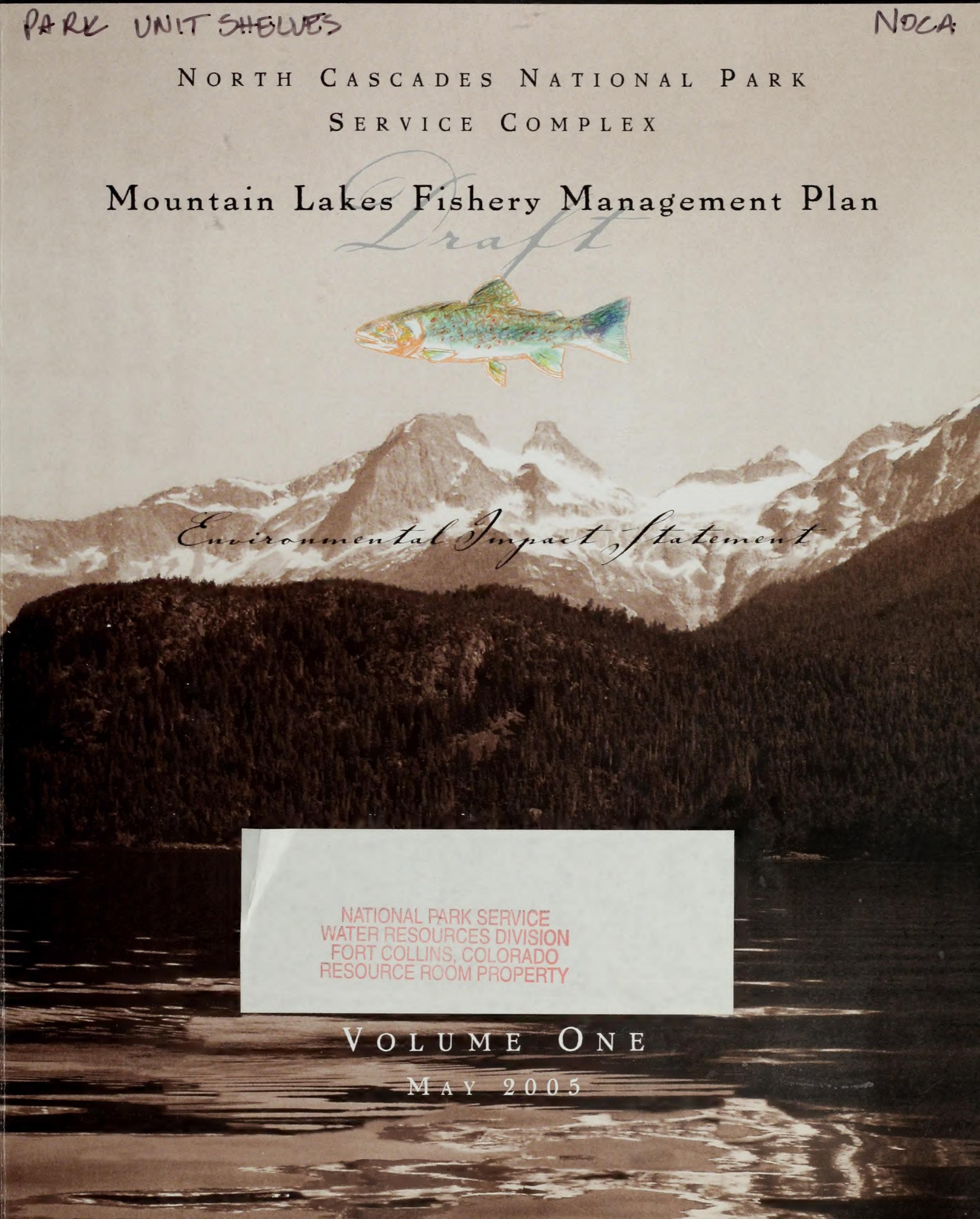
National Park Service
U.S. Department of the Interior

North Cascades National Park Service Complex

PARK UNIT SHELVES NOCA



NORTH CASCADES NATIONAL PARK SERVICE COMPLEX

Mountain Lakes Fishery Management Plan

Draft

Environmental Impact Statement

NATIONAL PARK SERVICE
WATER RESOURCES DIVISION
FORT COLLINS, COLORADO
RESOURCE ROOM PROPERTY

VOLUME ONE

MAY 2005

How to Comment on this Document

Comments on this *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS) are welcome. If you wish to respond to the information contained in this document, you may submit your comments by any one of several methods. It is important to note that all comments must be postmarked, transmitted, or logged no later than 90 days from the date the U.S. Environmental Protection Agency filing notice is published in the *Federal Register*. This deadline will be posted on the North Cascades National Park Service Complex website at http://www.nps.gov/noca/highlakes.htm and will be published in a press release in local and regional newspapers. Written comments can be mailed to

Bill Paleck, Superintendent
Mountain Lakes Fishery Management Plan/EIS
North Cascades National Park Service Complex
810 State Route 20
Sedro-Woolley, WA 98284-1239

Reviewers are encouraged to submit comments, ideas, or questions online at the National Park Service Planning, Environment, and Public Comment (PEPC) website (http://parkplanning.nps.gov/noca). Once at the website, click on the "Mountain Lakes Fishery Management Plan/EIS" link, then click on "Documents and Links," then click on the "Draft Mountain Lakes Fishery Management Plan/EIS" link—this will bring up the draft plan/EIS and a link to an online comment form.

You may hand deliver comments at one of the several public meetings to be announced in the media following release of this document. Meeting details will be posted on the project website listed above. Comments can be hand delivered to the North Cascades Complex headquarters in Sedro-Woolley (810 State Route 20). Comments can also be faxed to 360.856.1934, attention: Mountain Lakes Fishery Management Plan/EIS.

We may not consider anonymous comments. However, individual respondents may request that we withhold their address from the decision-making record, which we will honor to the extent allowable by law. There also may be circumstances in which we would withhold from the record a respondent's identity, as allowable by law. If you wish us to withhold your name and/or address, you must state this prominently at the beginning of your comment.

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

DRAFT MOUNTAIN LAKES FISHERY MANAGEMENT PLAN / ENVIRONMENTAL IMPACT STATEMENT

North Cascades National Park Service Complex, Washington

Lead Agency: National Park Service (NPS), U.S. Department of the Interior
Cooperating Agency: Washington Department of Fish and Wildlife (WDFW)

This *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS) evaluates a range of alternatives and management actions for 91 naturally formed mountain lakes in the North Cascades National Park Service Complex (North Cascades Complex) that currently have, or at one time had, a fish presence as a result of either documented or undocumented fish stocking activities. Under natural conditions, these 91 mountain lakes would be fishless, but available records indicate these lakes have either been stocked in the past or are stocked now. This plan/EIS assesses impacts that could result from continuation of the current management framework (the no-action alternative) or from implementation of any of the three proposed action alternatives. The purpose of the fishery management plan is to guide future actions by the NPS and WDFW that would conserve native biological integrity; provide a spectrum of recreational opportunities and visitor experiences, including sport fishing; and resolve the long-standing debate and conflicts over fish stocking in the 91 naturally fishless mountain lakes in the North Cascades Complex. Upon conclusion of the plan/EIS and decision-making process, one of the four alternatives would become the "Mountain Lakes Fishery Management Plan" and guide future actions for a period of 15 years.

Alternative A—No Action, Existing Management Framework of 91 Lakes (62 Lakes Have Fish). No new management actions were applied. This alternative assumes that the existing management decisions, without any new criteria or factors, would continue.

Alternative B, Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative). The proposed management framework would be to eliminate high densities of reproducing fish populations from lakes while allowing low densities of reproducing and nonreproducing fish populations in select lakes. After monitoring or evaluation, restocking of nonreproducing fish would be allowed in certain lakes only if impacts on biological resources could be minimized. Lakes that are currently fishless would remain fishless. The possible future outcome would be that recreational fishing opportunities may occur in up to 42 lakes.

Alternative C, Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish). The proposed management framework would be to eliminate high densities of reproducing fish populations from lakes while allowing low densities of reproducing and nonreproducing fish populations in select lakes in the Ross Lake and Lake Chelan National Recreation Areas (NRA) and to maintain currently fishless NRA lakes as fishless. The possible future outcome would be that 11 NRA lakes may have fish and 11 would be fishless, and 69 national park lakes would either remain fishless or become fishless over time.

Alternative D, 91 Lakes Would Be Fishless (Environmentally Preferred Alternative). The emphasis of this alternative would be to eliminate all fish from the mountain lakes in the study area. Currently, 62 of the 91 lakes have fish, 29 lakes are fishless.

The review period for this document will end 90 days after the U.S. Environmental Protection Agency has accepted this document and published a "Notice of Availability" in the *Federal Register*. All review comments must be received by that time and addressed to

Bill Paleck, Superintendent
Mountain Lakes Fishery Management Plan/EIS
North Cascades National Park Service Complex
810 State Route 20
Sedro-Woolley, WA 98284-1239

NATIONAL PARK SERVICE
WATER RESOURCES DIVISION
FORT COLLINS, COLORADO
RESOURCE ROOM PROPERTY

For further information, write the above address or call the superintendent's assistant at 360.856.5700, ext 351.

Digitized by the Internet Archive
in 2012 with funding from
LYRASIS Members and Sloan Foundation

http://archive.org/details/mountainlakesfis00vol1

EXECUTIVE SUMMARY

This *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS) analyzes a range of alternatives and management actions for the mountain lakes fishery in the North Cascades National Park Service Complex (North Cascades Complex) in Washington State. This plan/EIS assesses the impacts that could result from continuation of the current management framework (the no-action alternative) or implementation of any of the three action alternatives. Upon conclusion of the plan/EIS and decision-making process, one of the four alternatives would become the "Mountain Lakes Fishery Management Plan" and guide future fishery management actions for a period of 15 years.

The National Park Service (NPS) is the lead agency for development of this plan/EIS, and the Washington Department of Fish and Wildlife (WDFW) is a cooperating agency.

This plan/EIS is mostly programmatic in nature, which means it provides a framework for taking a range of management actions. Some actions would require additional, more site-specific analyses before they could be implemented. If additional analyses are required, environmental compliance, including an opportunity for public comment, would be completed.

PROJECT SITE LOCATION

The 684,000-acre North Cascades Complex is located in the northwest part of Washington State, with its northern boundary forming the international border with Canada. The North Cascades Complex is made up of three NPS administrative units: North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area. These three units make up the geographical study area for this plan/EIS, but the focus of this document is the 91 naturally fishless mountain lakes that have documented stocking records, as well as those where no stocking records exist but where observations or harvest of fish have been documented. These 91 lakes have reproducing and self-sustaining fish populations, have been stocked repeatedly because they contain nonreproducing fish, or have been stocked in the past but are now fishless.

State Route 20 follows the Skagit River and Skagit River Hydroelectric Project for much of its way through the North Cascades Complex.

The North Cascades Complex contains 561 natural water bodies that include lakes, tarns, and ponds. Approximately 245 of these water bodies are considered mountain lakes because of their elevation, size, and depth. At least 154 of the 245 lakes have always been, and would continue to be, fishless regardless of the alternative selected. Because no changes in this policy are anticipated for any of the 154 lakes, and because they have never been part of the managed fishery at the North Cascades Complex, they are not addressed further in this document, nor are the reservoirs, streams, and their associated beaver ponds.

"Map 1" (contained in the envelope that accompanied this plan/EIS) shows the locations of the 91 lakes: 69 lakes are in the national park, 7 are in Ross Lake National Recreation Area, and 15 are in Lake Chelan National Recreation Area. Of the 91 lakes in the study area, 90 are located in designated wilderness (Stephen T. Mather Wilderness) that overlays approximately 93% of the North Cascades Complex.

PURPOSE OF THE ACTION

The purpose of this plan/EIS is to guide management actions by the NPS and WDFW in order to

conserve native biological integrity

provide a spectrum of recreational opportunities and visitor experiences, including sport fishing

resolve the long-standing debate and conflicts over fish stocking in the naturally fishless mountain lakes in North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area (which together make up the three NPS administrative units known as "North Cascades National Park Service Complex" or "the North Cascades Complex")

Biological integrity refers to "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region" (Karr and Dudley 1981).

NEED FOR ACTION

In most NPS units, natural resources (including lakes and fish) are managed in accordance with the *Organic Act of 1916* and *NPS Management Policies*, which allow sport fishing unless it is specifically prohibited (NPS 2001a, 4.4.3), but prohibit stocking in most NPS waters. In the North Cascades Complex, fish have historically been managed by a combination of agencies and user groups. This is partly because the 1968 enabling legislation for the North Cascades Complex does not define the fishing and fish-stocking activities that would be allowed within its boundaries, and partly because the area has a history of fish management by the state of Washington and sport fishing groups. This history of fish management pre-dates the 1968 establishment of the North Cascades Complex by many years.

Because of the differences in policies and missions between the WDFW and the NPS, the two agencies drafted a Memorandum of Understanding in 1985, followed by a Supplemental Agreement in 1988 that established a mutually agreed to list of lakes in North Cascades National Park that the WDFW would stock with fish as part of its fish management program while further studies were being done. A long-term research study was then initiated to determine how continued stocking practices would affect native biota in mountain lakes.

"Biota" refers to the combined plant and animal life of a particular region.

Before this research could be completed, the NPS was challenged in court by the North Cascades Conservation Council on several issues relating to management of the North Cascades Complex. As a result, the NPS entered into a 1991 Consent Decree, wherein the NPS agreed to complete its research and then

"conduct a NEPA [*National Environmental Policy Act*] review of the fish stocking of naturally fish-free lakes." The research was completed in July 2002 (Liss et al. 2002) by a team that included scientists from the U.S. Geological Survey (USGS) - Biological Resources Division and Oregon State University (OSU). The research was completed in three phases, and full reports of the findings are available at http://www.nps.gov/noca/pphtml/relatedlinks.html. This plan/EIS was initiated shortly after the research was completed and is the document required in the 1991 Consent Decree.

OBJECTIVES IN TAKING ACTION

Objectives are more specific statements of purpose that support the goals an alternative must meet, to a large degree, for this plan/EIS to be considered a success. Meeting objectives to a large degree is part of what makes an alternative "reasonable." Objectives also support the purpose of this plan/EIS as stated in the "Purpose of the Action" section above and help to resolve the need for action.

The following objectives were developed for this plan/EIS:

> Obtain support from interested parties and groups to implement a new management plan for mountain lakes within the North Cascades Complex should the governing agencies decide a new plan is needed.
>
> Advance the protection and rehabilitation of native biological integrity by maintaining native species abundance, viability, and sustainability.
>
> Provide a spectrum of recreational opportunities, including sport fishing, while minimizing impacts to the biological integrity of natural mountain lakes.
>
> Apply science and research in decision-making at multiple spatial scales that include landscape, watershed, lake cluster, and individual lakes.
>
> Provide to the public and interested parties full and open access to available information.

BACKGROUND

HISTORY OF FISH MANAGEMENT IN NORTH CASCADES MOUNTAIN LAKES

Settlers began stocking North Cascades lakes in the late 1800s with exotic (nonnative) fish. By the 20th century, stocking was a routine management practice of the U.S. Forest Service and various counties. In 1933 the Washington Department of Game (currently the WDFW) assumed responsibility for stocking mountain lakes throughout the state in order to establish and maintain a recreational fishery. The department's involvement grew largely out of the need to prevent haphazard stocking by individuals without expertise in biology. With particular emphasis on systematic assessment of fish species and stocking rates, the department conducted the first high-lakes fisheries research. Since its creation, many agencies and groups have collaborated to assist in managing the natural resources in the North Cascades Complex. These include state and federal agencies, such as the WDFW, and sport fishing groups such as the Washington State Hi-Lakers and Trail Blazers, Inc.

Fish stocking Thunder Lake in the early years.

Fish stocking in the mountain lakes took place for many years prior to the establishment of the North Cascades Complex in 1968; however, the enabling legislation for this newly formed unit of the national park system did not define the fishing and fish-stocking activities that would be allowed within its boundaries; thus, the appropriateness of continued fish stocking in the naturally fishless mountain lakes was an issue debated between the NPS and WDFW for many years.

To resolve differences in policy and to foster a spirit of cooperation, the NPS and WDFW negotiated a series of agreements beginning in 1979 that allowed stocking to continue in select lakes in the North Cascades Complex. Currently, the management of mountain lakes is performed under a temporary extension of the 1985 Memorandum of Understanding and 1988 Supplemental Agreement between the two agencies. Both of these documents were written "to continue cooperative efforts in management of protection and enhancement of the fisheries and wildlife resources of mutual concern." The Memorandum of Understanding provided the following three management directives for both the NPS and the WDFW:

> To consult with the Department [WDFW] prior to initiating research projects or implementing plans, programs, or regulations affecting fish and wildlife species distribution, numbers, or public use of fish and wildlife found within areas administered by the Service [NPS].
>
> To practice those forms of management which will benefit fish and wildlife, and their habitats, and to maintain or restore their natural and historic distribution and abundance, consistent with the respective Service [NPS] policies and park objectives.
>
> To permit the harvest of fish and wildlife in accordance with applicable state laws and regulations of the Department [WDFW] in those areas under the jurisdiction of the Service [NPS], which are open to hunting and/or fishing. It is recognized that some park regulations may vary for management purposes.

To be able to continue stocking in light of NPS policies generally prohibiting it, a memorandum from the NPS Director was issued in 1986 (hereinafter referred to as the "policy waiver"). The policy waiver states "fishing is an acceptable recreational activity in the park, provided it is done consistent with *NPS Management Policies* and with provisions of the *General Management Plan*, and other approved plans." The policy waiver only allowed stocking with fish species that are native to the national park or native to the ecological region. The waiver acknowledged long-standing fish-stocking practices and allowed for continued stocking in select lakes while ecological research was conducted to determine the impacts of fish stocking. A long-term research study was initiated by Oregon State University soon after the 1988 Supplemental Agreement was finalized. The Supplemental Agreement between the NPS and WDFW that permits fish stocking in the national park was reaffirmed in February 2000 and again in July of 2002. The agreement expired in December 2004, and any future agreements between the NPS and WDFW concerning mountain lakes fishery management, including fish stocking in the national park, will depend on the outcome of this plan/EIS process.

IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION

The enabling legislation for the North Cascades Complex does not mention fish stocking, and the legislative record regarding fish stocking in the North Cascades Complex is not clear. The language in the enabling legislation for the portions of the North Cascades Complex in the national recreation areas does affirm that fishing is an important recreational use, but it does not mention fish stocking as being an appropriate means of fishery management. The *Washington Park Wilderness Act of 1988* (WPWA) established 93% of the North Cascades Complex as Stephen T. Mather Wilderness and directed the NPS to manage the wilderness in accordance with the *Wilderness Act of 1964*. At the time the WPWA was passed, NPS policies prohibited fish stocking in naturally fishless waters, and the WPWA did not include a provision that allowed stocking.

The North Cascades Complex contains some of the most rugged and remote wilderness in the contiguous United States.

Although the *Wilderness Act* implies that management actions that manipulate natural processes in wilderness conflict with wilderness values, stocking is not expressly prohibited in the Act. According to the definition of wilderness in the *Wilderness Act*, wilderness must retain its "primeval character and influence" so that it "appears to have been affected primarily by the forces of nature." This language has been interpreted in the scientific literature to affirm two closely linked values that are fundamental components of wilderness character: naturalness and wildness. Naturalness has been defined as the native compositions, patterns, and processes of an area. Wildness has to do with ensuring that wilderness areas are minimally influenced by human intervention, so those who enter wilderness can experience primitive and unconfined forms of recreation. Though recreational fishing is widely regarded as an important and traditional use of wilderness, the role of stocking to create and maintain an artificial fishing opportunity in naturally fishless mountain lakes is viewed by many as an artificial manipulation of both wildness and naturalness (Landres et al. 2001). These views are supported by a wide body of scientific research into the impacts of fish stocking, including findings specific to lakes in the North Cascades Complex. However, some disagree with these views and maintain that if nonnative fish were stocked appropriately, there would be no unacceptable adverse impacts on wilderness values because biological integrity would be conserved.

Fish stocking has been allowed to continue in the North Cascades Complex under a 1986 policy waiver. Should a management alternative that allows for continued stocking be selected through this plan/EIS decision-making process, a new policy waiver may not be granted for several reasons. First, various national parks (Sequoia-Kings Canyon National Park, Yosemite National Park, Glacier National Park, Rocky Mountain National Park, and Yellowstone National Park) have discontinued stocking. If this plan/EIS process resulted in the selection of an alternative that allowed for continued stocking, issuance of a policy waiver to the North Cascades Complex could encourage other state fish and wildlife agencies to revisit the issue of stocking in NPS units where stocking has been discontinued. Second, policy waivers are only temporary and do not provide a permanent solution because they can be rescinded as circumstances change. The goal of this plan/EIS is to forge a lasting solution for mountain lakes fishery management in the North Cascades Complex. Finally, the minimum requirement analysis for fish stocking in the Stephen T. Mather Wilderness indicates that stocking is not necessary to meet the minimum requirements for administration of the area, and the *Wilderness Act* is unclear whether stocking is allowed in designated wilderness areas. For these three reasons, a policy waiver would not be pursued if this plan/EIS process resulted in the selection of an alternative that included continued fish stocking.

The NPS has determined that fish stocking in the Stephen T. Mather Wilderness would only be implemented if Congress granted the NPS the unambiguous legal authority to do so. Therefore, should a management alternative that allows for continued stocking be selected through this plan/EIS decision-making process, the NPS intends to ask Congress for a change to the North Cascades Complex enabling legislation to clarify how the mountain lakes should be managed. The following is an example of clarifying legislation that would allow stocking to continue in the North Cascades Complex:

> Notwithstanding any other provision of law, a fisheries management program that includes the stocking of fish in select lakes within the North Cascades National Park Service Complex is authorized so long as both the National Park Service and the State of Washington agree on the lakes, species of fish, and number of fish to be stocked.

A change in the enabling legislation for the North Cascades Complex to allow for continued fish stocking would set a precedent for this NPS unit, and possibly others that have, or may have in the future, fish-stocking issues. If Congress should choose to allow stocking through a change in the enabling legislation, it will have clarified that fish stocking is an appropriate activity in the North Cascades Complex. That unambiguous clarification would allow the NPS to implement any of the management alternatives that include the practice of stocking. Congressional action to allow fish stocking would also honor various verbal commitments in support of stocking that proponents believe were made by federal officials prior to establishing the North Cascades Complex but never codified in law.

Congressional action to clarify enabling legislation is an intricate process that could take several years. If the NPS does not receive clarification from Congress by the time a record of decision for this plan/EIS is issued, alternative D (91 Lakes Would Be Fishless) would be implemented until clarification is received.

APPLICATION OF RESEARCH

This plan/EIS incorporates the results of the OSU study and other research into the impact analysis of the four alternatives for management of the mountain lakes fishery. The Technical Advisory Committee for this plan/EIS applied the research results and ecological concepts to

- develop management alternatives that conserve biological integrity while allowing fish to occur in some lakes
- describe the ecosystem functions and human values that could be potentially affected by fishery management actions
- evaluate the potential impacts of management alternatives on ecosystem functions and human values

The Technical Advisory Committee is an interdisciplinary planning team comprised of NPS resource specialists, WDFW biologists, and other individual resource specialists.

The use of research results, including widely accepted ecological principles, helped to achieve the stated objective of ensuring that decisions would be made in accordance with the best available science.

The Technical Advisory Committee adopted the following common definition of biological integrity:

> The capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region (Karr and Dudley 1981).

To relate the purpose of "conserving biological integrity" to mountain lakes fishery management, the Technical Advisory Committee drew upon one of the principle conclusions of the OSU research: the ecological effects of nonnative trout are related to the reproductive status and abundance of trout in lakes. The Technical Advisory Committee interpreted this finding to mean that lakes with the lowest degree of biological integrity (or greatest departure from biological integrity or pristine conditions) contained reproducing populations of nonnative trout or char that had achieved high densities. On the other end of the biological integrity spectrum, the Technical Advisory Committee assumed mountain lakes that had never been stocked represented the highest degree of biological integrity.

The Technical Advisory Committee took the general concept of biological integrity and defined it in the context of this plan/EIS. This approach allowed the committee to formulate a conceptual framework for "conserving biological integrity" by relating how the reproductive status and abundance of nonnative trout influenced the biological integrity of the mountain lakes. This conceptual framework was used to craft management alternatives B and C based on the hypothesis that the biological integrity of mountain lakes could potentially be conserved by managing for nonreproducing trout at low densities in some lakes and managing for fishless conditions in other lakes.

DEVELOPING MANAGEMENT ACTIONS FOR ALTERNATIVES B AND C

During its review of the research, the Technical Advisory Committee defined various decision-making criteria (ecological risk factors) for the 91 lakes. Based partly on these factors, the committee then developed 10 standard adaptive management actions that were applied to a differing subset of lakes in alternatives B and C. For alternative A, the management actions were not applied to the lakes because it represents current management that would not change if alternative A were selected. Only 4 of the 10 management actions were applied to lakes under alternative D, which proposes that all 91 lakes would eventually be fishless.

Adaptive management incorporates monitoring and research into conservation actions. Specifically, it is the integration of planning, management, and monitoring to test assumptions in order to adapt and learn.

The standardized adaptive management actions are shown in table ES-1, and a lake-by-lake application of the management actions is in table ES-2 (these tables are located at the end of this executive summary).

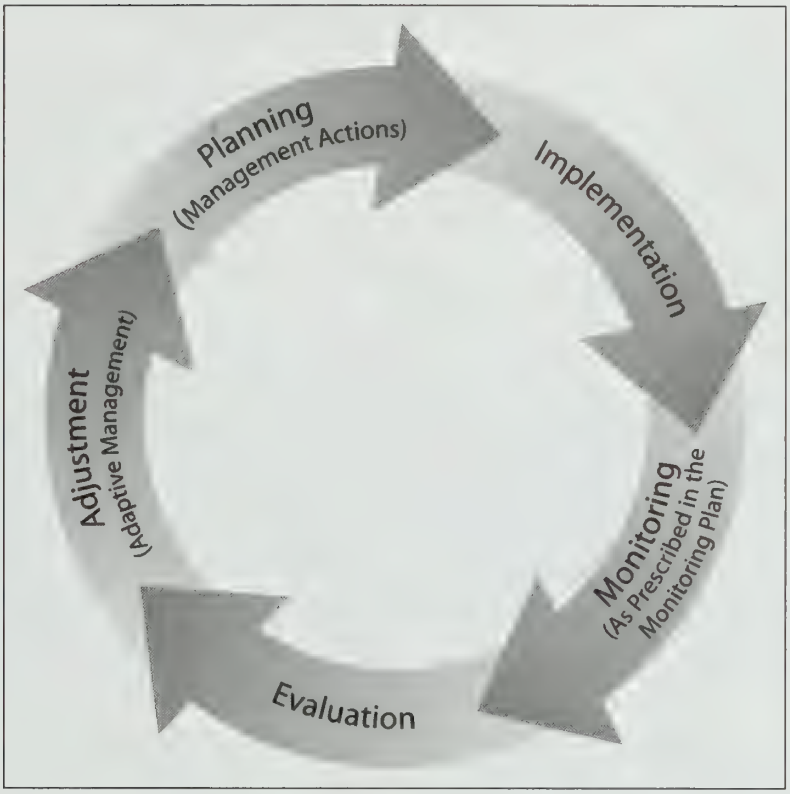
The Technical Advisory Committee recognized that each management alternative was developed with scientific information and data that are provisional and possibly incorrect. In light of this uncertainty, the committee included the principle of adaptive management (see figure ES-1) as an element common to all action alternatives and also developed a lake monitoring plan that would incorporate adaptive management in order to evaluate management actions and create a mechanism for changing those actions if management goals were not being achieved.

ALTERNATIVES

This plan/EIS evaluates four alternatives for management of the 91 study area lakes in the North Cascades Complex (table ES-3 provides a summary comparison of the four alternatives). The three action alternatives (B, C, and D) have the following elements in common:

1. **Adaptive management.** The action alternatives would incorporate the principle of adaptive management using monitoring and evaluation to determine if management actions were achieving objectives.
2. **Outreach and education.** The NPS would establish a long-term public outreach campaign to help educate and inform the public about the selected alternative.
3. **Partnerships.** The NPS would actively seek partnerships with the WDFW, fishing groups, and the public to implement fishery management actions.
4. **Lake treatment methods.** Each lake has its own particular chemical and physical characteristics that dictate the best means of removing fish; therefore, methods of removing fish would differ among lakes, but the prescribed method (mechanical, chemical, or natural) of fish removal for a particular lake would not differ across the alternatives.

FIGURE ES-1: ADAPTIVE MANAGEMENT PROCESS



Mechanical Methods. The three intensive mechanical methods of removing fish (gillnetting/electrofishing/trapping) would not be used independently but in combination to treat appropriate lakes. A varied combination of gillneting, electrofishing, fyke nets, and traps near spawning areas would be used to catch and remove fish from lakes generally smaller than 5 acres in surface area and less than 30 feet deep. The exact choice of equipment would depend upon lake conditions. For small mountain lakes, the method that has shown the most promise is gillnetting in combination with electrofishing.

> *Mitigation measures* — No nets would be left unsupervised. Crews would free any wildlife observed in the nets. In order to mitigate trampling of shoreline vegetation, crews would be kept small and would walk in the lake (to the extent possible), rather than along the shoreline when setting nets.

Chemical Methods. The antibiotic, antimycin, has been used since the 1960s for fish removal. Small amounts of the chemical are required to kill fish because antimycin is toxic to fish in extremely low concentrations. The concentration of antimycin necessary to remove fish has a fairly wide range of impacts on aquatic organisms, depending upon taxonomic groups. For example, the toxicity of antimycin to aquatic invertebrates is similar to that of fish (Finlayson et al. 2002). Antimycin is considered to be harmless to waterfowl, mammals, and humans at the relatively minute (4–8 parts per billion) concentrations needed to control trout (Rosenlund and Stevens 2002; Schnick 1974).

Treatment with antimycin would occur during late summer and fall because water flows are lowest in the fall, meaning less water is moving into and out of the lake. Antimycin would be diluted with lake water and then injected into the prop wash of a small motor. Bilge pumps would also be used to help mix the chemical in deeper water. Crews on the shoreline would use a diluted mixture of antimycin to hand treat areas that could not be reached by boat.

> *Mitigation measures* — Antimycin that is dripped into a stream flowing out of a lake could be carried to downstream waters. Because antimycin is very sensitive to oxidation, exposing it to oxygen rapidly breaks it down, resulting in loss of toxicity (Rosenlund 1992). Potassium permanganate, an oxidizer, would be placed at outlet streams to remove residual antimycin and prevent it from traveling downstream. Antimycin dose rates would be double verified and monitored to prevent inadvertent overdoses, and potassium permanganate would be on hand as a contingency measure. In order to mitigate trampling of shoreline vegetation, crews would be kept small and would walk in the lake (to the extent possible), rather than along the shoreline when applying antimycin. Crews treating lakes with antimycin would be required to wear eye protection and gloves and would also receive safety briefings.

Natural Methods. Lakes that would be candidates for the natural treatment method are those that contain only nonreproducing stocked fish. For lakes that contain only stocked fish that do not reproduce, the method of treatment may be as simple as ceasing stocking. The initial decline in fish densities could be accelerated by providing incentives for anglers, such as increased bag limits. For lakes where the rate of reproduction is very low and likely not to occur at all in some years, it may also be possible to use natural attrition to remove the fish over a period of years, especially if natural reproduction has been supplemented by stocking of nonreproducing fish.

> *Mitigation measures* — Increased trampling of shoreline vegetation could occur as a result of incentives that encourage anglers to increase the amount of fishing to help reduce fish populations. The NPS would provide additional educational information about shoreline sensitivity by posting information on bulletin boards, the website for the North Cascades Complex, and at visitor centers.

ALTERNATIVE A: NO ACTION, EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

The management framework dictates the parameters under which the fishery management program is applied. The framework controls which lakes are stocked, stocking densities and frequencies, types of fish, methods used for stocking, and monitoring efforts. Under the current management framework for alternative A, the 62 lakes that currently contain fish would continue to be managed as they are today (see tables ES-1 and ES-2).

Alternative A

62 lakes would have fish
29 lakes would remain fishless

The no-action alternative would continue existing management practices in the 91 lakes slated for management consideration in the study area. Fish occur in 62 of the 91 lakes; the remaining 29 lakes are currently fishless and not actively managed for fish. This would continue under existing management. Of the 62 lakes, 40 are in North Cascades National Park and managed by the WDFW under the terms of the 1988 Supplemental Agreement to the 1985 Memorandum of Understanding. The remaining 22 of 62 lakes are in Ross Lake and Lake Chelan National Recreation Areas. The WDFW manages 19 of the 22 lakes as a recreational fishery; these 19 lakes are not part of the Supplemental Agreement but are managed by the WDFW according to historical practices. Three of the 22 lakes are also located inside the national recreation areas but are not managed under the 1988 Supplemental Agreement nor are they actively managed by the WDFW. Table ES-2 shows the status of the 91 lakes.

The continued stocking of fish in select lakes in the North Cascades Complex has occurred under both the Memorandum of Understanding and the Supplemental Agreement, in addition to a policy waiver issued by the NPS director in 1986.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

This alternative would conserve biological integrity in lakes by eliminating or reducing (if elimination proved infeasible) reproducing fish populations. Sport fishing would continue to be managed in lakes where the risks to biological integrity could be minimized. The proposed management framework under alternative B would be to eliminate high densities of reproducing fish populations from lakes in the study area while allowing low densities of reproducing and nonreproducing fish populations. Management actions would be applied to the 91 study area lakes throughout the North Cascades Complex (see tables ES-1 and ES-2). Up to 20 lakes would be permanently returned to fishless conditions (added to the 29 currently fishless lakes, the potential outcome of this alternative would be 49 fishless lakes). The restocking of nonreproducing fish would be allowed only where impacts on biological resources could be minimized. Based on the best available science, some lakes could be restocked with low densities of nonreproducing fish once reproducing fish have been removed. Lakes where critical information is missing would not be stocked until that information becomes available. An extensive monitoring program would be implemented to adjust future management and to avoid unacceptable effects on native biota from fish presence.

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

Alternative C applies a new management framework to the 91 lakes in the study area, wherein 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish, and 2 lakes would be evaluated for restocking. Of the other 11 lakes in the national recreation areas, 3 would remain fishless, 3 would have high-density reproducing fish removed, and stocking would be discontinued in 5 lakes. The remaining 69 lakes are in the national park portion of the North Cascades Complex and would be returned to their natural fishless condition or would remain fishless.

Alternative C

8 lakes would have fish
80 lakes would be fishless
3 lakes would be evaluated for restocking

The proposed management framework would eliminate or reduce reproducing fish from lakes in the national recreation areas because high densities of reproducing fish populations can alter the lake ecosystem and negatively effect native biota. Restocking of nonreproducing fish would be allowed only where biological resources could be protected in lakes located in the national recreation areas. Based on best available science, some lakes could be restocked with nonreproducing fish at low densities once reproducing fish have been removed. Where critical information is missing, lakes would not be stocked until such information becomes available. As with alternative B, a monitoring program would be incorporated to adjust future management actions in order to avoid unacceptable effects on native biota from fish presence.

ALTERNATIVE D: 91 LAKES WOULD BE FISHLESS (ENVIRONMENTALLY PREFERRED ALTERNATIVE)

The emphasis of this alternative would be to eliminate all fish from mountain lakes in the study area. Currently, 62 of the 91 study area lakes have fish and 29 are fishless. Under alternative D, four management actions would be available for a given lake (see table ES-2).

Alternative D

91 lakes would be fishless

Stocking would be discontinued in all lakes currently stocked, and the stocked fish would die off within several years. Reproducing populations of fish would be gradually removed over time, and the rate of removal would depend upon the availability of resources (funding and personnel) and differences among methods of removal.

Alternative D was crafted to meet the spirit and intent of *NPS Management Policies* by discontinuing stocking and eventually removing reproducing fish populations from mountain lakes wherever feasible.

ISSUES AND IMPACT TOPICS

Issues are problems, opportunities, and concerns regarding the current and potential future management concepts for managing aquatic resources, impacts of anglers, and sport-fishing opportunities in the 91 mountain lakes that are included in this plan/EIS. The issues were identified by the NPS, WDFW, other agencies, and the public throughout the scoping process. The impact topics are a more refined set of concerns that were analyzed for each of the management alternatives. The impact topics were derived from the issues and were used to examine the extent to which a problem would be made better or worse by the actions of a particular alternative (the environmental consequences of an alternative).

The issues include

Predation and competition. Nonnative fish have measurably changed the composition and abundance of native aquatic organisms in some lakes. The most significant impacts are caused by reproducing populations of stocked fish that have become self-sustaining.

Hybridization with native fish. Nonnative fish are dispersing downstream from some lakes and hybridizing (interbreeding) with native fish. Hybridization could harm bull trout (federally threatened), westslope cutthroat trout, and other native trout populations.

Conflicting social/wilderness values. Some people strongly oppose the management of a nonnative fishery in North Cascades Complex mountain lakes that were naturally fishless. Others believe that the mountain lakes fishery provides an unparalleled opportunity for high-lakes fishing that cannot be duplicated elsewhere.

Legislative ambiguity. The enabling legislation and legislative history for the North Cascades Complex are not clear with respect to fishing and fish stocking. The NPS believes an affirmative legislative clarification from Congress would be needed to justify continued fish stocking in naturally fishless mountain lakes in the North Cascades Complex / Stephen T. Mather Wilderness.

The impact topics analyzed in this plan/EIS include

Aquatic organisms—includes plankton, macroinvertebrates, amphibians, and native fish

Other wildlife—such as fish-eating wildlife that have benefited from stocked fish at a number of lakes in the North Cascades Complex

Special status wildlife and plant species—includes native fish, amphibians, and other vertebrates

Vegetation—particularly riparian areas

Cultural resources—includes archeological resources, cultural landscapes, historic structures, and ethnographic resources

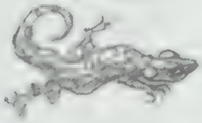
Human Health—analyzes potential effects of persistent organic pollutants, methylmercury, and chemical treatments to remove fish

Visitor use and experience—includes recreational use, social values, and wilderness values

Management and operation of the North Cascades Complex—looks at current and future budgets and the costs related to fishery management now and in the future.

fish

amphibians



zooplankton

phytoplankton

ENVIRONMENTAL CONSEQUENCES

The environmental impacts of each action alternative were analyzed and compared to alternative A (no action). Table ES-4 summarizes the environmental consequences of the alternatives for each of the impact topics listed above.

TABLE ES-1: DESCRIPTION OF MANAGEMENT ACTIONS

This table presents a standard set of fishery management actions for implementation under alternatives B and C. Note that management actions under alternative A would not change from current management, and management actions under alternative D only involve stopping stocking and removing all fish. The standard management actions in this table are broken down into classes 1-4, based on the Technical Advisory Committee's current understanding of the presence, reproductive status, and density of fish in the lakes. These standard management actions would require periodic monitoring and evaluation to facilitate adaptive management.	
For a lake that is currently fishless:	
1	The lake would remain fishless.
For a lake with high densities of reproducing fish, apply one of the following management actions:	
2A	Remove all reproducing fish. Monitor the recovery of native organisms and keep the lake fishless.
2B	Remove all reproducing fish. Monitor lake conditions and use the results to determine whether or not to restock the lake with nonreproducing fish. If the lake is restocked and monitoring results indicate fish are causing major adverse impacts, then fish densities would be reduced by changing stocking densities, stocking cycles, or the species of stocked fish. If these management changes do not work, then discontinue stocking (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
2C	Remove all reproducing fish. Implement a resting period (that is, keep the lake fishless for a period of time) to foster recovery of native organisms. The duration of the resting period will be determined on a lake-by-lake basis based upon monitoring results. If monitoring results indicate favorable recovery of native organisms, then restock the lake with low densities of nonreproducing fish and monitor lake conditions. If monitoring results indicate fish are causing major adverse impacts, then reduce stocking densities, stocking cycles, or the species of stocked fish. If these management changes do not work, then discontinue stocking (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
For a lake with low densities of reproducing fish, apply one of the following management actions:	
3A	Remove all reproducing fish. Monitor the recovery of native organisms, and keep the lake fishless.
3B	Evaluate the reproductive status of fish and the status of indicator taxa. If fish density is high enough that impacts on indicator taxa may be major, apply prescription 2A, 2B, or 2C. If fish densities and impacts to indicator taxa are low, maintain the low fish densities. If monitoring data indicate fish are causing major adverse impacts, then completely remove fish (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
3C	For lakes with extremely low densities of fish, augment the population with supplemental stocking and monitor indicator taxa. If monitoring results indicate fish are causing major adverse impacts, then stop stocking and remove all fish (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
For a lake that has been stocked and does not contain a reproducing population of fish, apply one of the following management actions:	
4A	Discontinue stocking. Monitor the recovery of native organisms.
4B	Lack of data for decision-making. Discontinue stocking and monitor lake conditions. If the lake is restocked and monitoring results indicate fish are causing major adverse impacts, then discontinue stocking (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
4C	Continue stocking with low densities of fish expected not to reproduce in the lake. If monitoring results indicate fish are causing major adverse impacts, then reduce stocking densities, stocking cycles, or the species of stocked fish. If these management changes do not work, then discontinue stocking (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).

TABLE ES-2: MANAGEMENT ACTIONS FOR EACH OF THE 91 LAKES

Note: The shaded rows indicate the 22 lakes that are in Ross Lake and Lake Chelan National Recreation Areas; the other 69 lakes are in the national park portion of the North Cascades Complex.

Lake Name	NPS Lake Code	Current Condition of Lake (as represented under alternative A)	Management Action Alternative B	Alternative C	Alternative D
Azure	MP-09-01	Fishless	1	1	1
Battalion	MLY-02-01	High density reproducing fish	2B	2B	2A
Bear	MC-12-1	High density reproducing fish	2C	2A	2A
Berdeen	M-08-01	High density reproducing fish	2C	2A	2A
Berdeen, Lower	M-07-01	High density reproducing fish	2A	2A	2A
Berdeen, Upper	M-09-01	High density reproducing fish	2A	2A	2A
Blum (Largest/Middle, No. 3)	M-11-01	High density reproducing fish	2B	2A	2A
Blum (Lower/West, No. 4)	LS-07-01	High density reproducing fish	2C	2A	2A
Blum (Small/North, No. 2)	MC-01-01	Fishless	1	1	1
Blum (Vista/Northwest, No. 1)	MC-02-01	Fishless	1	1	1
Bouck, Lower	DD-04-01	High density reproducing fish	2C	2C	2A
Bouck, Upper	DD-05-01	Stocked with nonreproducing fish	4A	4A	4A
Bowan	MR-12-01	Stocked with nonreproducing fish	4A	4A	4A
Coon	MM-10-01	Stocked with nonreproducing fish	4C	4C	4A
Copper[a]	MC-06-01	Stocked with nonreproducing fish	4B	4A	4A
Dagger	MR-04-01	High density reproducing fish	2B	2A	2A
Dee Dee, Upper	MR-15-01	High density reproducing fish	2B	2A	2A
Dee Dee/Tamarack, Lower	MR-15-02	Stocked with nonreproducing fish	4A	4A	4A
Despair, Lower	M-14-01	Fishless	1	1	1
Despair, Upper	M-13-01	Fishless	1	1	1
Diobsud No. 1	LS-01-01	High density reproducing fish	2A	2A	2A
Diobsud No. 2, Lower	LS-02-01	High density reproducing fish	2B	2A	2A
Diobsud No. 3, Upper	LS-03-01	Stocked with nonreproducing fish	4A	4A	4A
Doubtful	CP-01-01	High density reproducing fish	2C	2A	2A
Doug's Tarn	M-21-01	High density reproducing fish	2C	2A	2A
East, Lower	MC-14-02	Fishless	1	1	1
East, Upper	MC-14-01	Fishless	1	1	1
Firn	MP-02-01	Low density reproducing fish	3B	3A	3A
Green	M-04-01	High density reproducing fish	2B	2A	2A
Green Bench	LS-04-01	Fishless	1	1	1
Hanging	MC-08-01	High density reproducing fish	2A[b]	2A[b]	2A[b]
Hidden	SB-01-01	Low density reproducing fish	3C	3A	3A
Hidden Lake Tarn	EP-14-01	Stocked with nonreproducing fish	4A	4A	4A
Hi-Yu	M-01-01	Stocked with nonreproducing fish	4B	4A	4A
Hozomeen	HM-02-01	High density reproducing fish	2A	2A	2A
Ipsoot	LS-06-01	Low density reproducing fish	3B	3A	3A
Jeanita	DD-01-01	Low density reproducing fish	3B	3A	3A
Kettling	MR-05-01	High density reproducing fish	2A	2A	2A
Kwahnesum	MC-07-01	Stocked with nonreproducing fish	4A	4A	4A
McAlester	MR-10-01	High density reproducing fish	2B	2B	2A
Middle, Lower	MC-16-02	Fishless	1	1	1
Middle, Upper	MC-16-01	Fishless	1	1	1
Monogram	M-23-01	High density reproducing fish	2C	2A	2A
Monogram Tarn	M-23-11	Stocked with nonreproducing fish	4A	4A	4A
Nert	M-05-01	Stocked with nonreproducing fish	4A	4A	4A

TABLE ES-2: MANAGEMENT ACTIONS FOR EACH OF THE 91 LAKES (CONTINUED)

Lake Name	NPS Lake Code	Current Condition of Lake (as represented under alternative A)	Management Action		
			Alternative B	Alternative C	Alternative D
Noisy Creek, Upper	LS-14-01	Fishless	1	1	1
No Name	PM-01-01	Stocked with nonreproducing fish	4C	4A	4A
Panther Potholes, Lower	RD-05-02	Stocked with nonreproducing fish	4A	4A	4A
Panther Potholes, Upper	RD-05-01	Fishless	1	1	1
Pegasus	EP-10-01	Fishless	1	1	1
Pond SE of Kettling Lakes	MR-09-01	Stocked with nonreproducing fish	4C	4C	4A
Quill, Lower	M-24-02	Stocked with nonreproducing fish	4B	4A	4A
Quill, Upper	M-24-01	Stocked with nonreproducing fish	4B	4A	4A
Rainbow	MR-14-01	High density reproducing fish	2C	2C	2A
Rainbow, Upper (North)	MR-13-01	Fishless	1	1	1
Rainbow, Upper (South)	MR-13-02	Stocked with nonreproducing fish	4A	4A	4A
Rainbow, Upper (West)	MM-11-01	Stocked with nonreproducing fish	4A	4A	4A
Redoubt	MC-11-01	Fishless	1	1	1
Reveille, Lower	MC-21-02	Fishless	1	1	1
Reveille, Upper	MC-21-01	Fishless	1	1	1
Ridley	HM-03-01	Stocked with nonreproducing fish	4C	4C	4A
Sky	EP-13-01	Fishless	1	1	1
Skymo	PM-03-01	High density reproducing fish	2C	2A	2A
Sourdough	PM-12-01	High density reproducing fish	2B	2A	2A
Sourpuss	ML-01-01	Fishless	1	1	1
Stiletto	MR-01-01	Stocked with nonreproducing fish	4B	4A	4A
Stout	EP-09-02	Low density reproducing fish	3B	3A	3A
Stout, Lower	EP-09-01	Low density reproducing fish	3B	3A	3A
Sweet Pea	ML-02-01	Stocked with nonreproducing fish	4C	4A	4A
Talus Tarn	M-06-01	Fishless	1	1	1
Tapto, Lower	MC-17-03	Fishless	1	1	1
Tapto, Middle	MC-17-02	Fishless	1	1	1
Tapto, Upper	MC-17-01	Fishless	1	1	1
Tapto, West	MC-17-04	Fishless	1	1	1
Thornton, Lower	M-20-01	Low density reproducing fish	3C	3A	3A
Thornton, Middle	M-19-01	Stocked with nonreproducing fish	4C	4A	4A
Thunder	RD-02-01	Fishless	1	1	1
Tiny	MC-15-01	Fishless	1	1	1
Torment	ML-03-01	Stocked with nonreproducing fish	4A	4A	4A
Trapper	GM-01-01	Low density reproducing fish	3B	3A	3A
Triplet, Lower	SM-02-01	High density reproducing fish	2C	2C	2A
Triplet, Upper	SM-02-02	High density reproducing fish	2A	2A	2A
Triumph	M-17-01	Stocked with nonreproducing fish	4C	4A	4A
Unnamed	FP-01-01	Fishless	1	1	1
Unnamed	MR-11-01	Stocked with nonreproducing fish	4C	4C	4A
Unnamed	MR-16-01	Low density reproducing fish	3B	3B	3A
Vulcan	ML-04-01	Fishless	1	1	1
Wilcox/Lillie, Upper	EP-06-01	High density reproducing fish	2A	2A	2A
Wilcox/Sandie, Lower	EP-05-01	High density reproducing fish	2C	2A	2A
Wild	MC-27-01	Fishless	1	1	1
Willow	HM-04-01	Stocked with nonreproducing fish	4C	4C	4A

Notes:

a. In August 2004, a large fish kill was observed in Copper Lake, possibly due to disease. Further surveys are needed to confirm that the lake is fishless.

b. Remove all reproducing fish pending agreement with British Columbia.

TABLE ES-3: ALTERNATIVES ELEMENTS SUMMARY

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
General Concept				
Lake management	No change in the way the North Cascades Complex fishery is managed. Lakes that are currently stocked would continue to be stocked, lakes with reproducing fish would be allowed to maintain reproducing fish, and all lakes without fish would continue to be fishless.	Manage 91 lakes in the study area that have a fish history from either a documented or undocumented history of fish stocking; the 91 lakes would be managed under a new adaptive management framework, which includes taking action to remove fish from select lakes.	Manage 91 lakes in the study area that have a fish presence from either a documented or undocumented history of fish stocking. 22 lakes are in the two national recreation areas (NRA) would be managed under a new adaptive management framework, which includes taking action to remove fish from some lakes (11 of the 22 NRA lakes may continue to have fish). 69 lakes in the national park either would remain fishless or be returned to fishless conditions.	The 91 lakes in the study area that have a history of fish presence from either documented or undocumented fish stocking would all become fishless over time, and stocking would be eliminated.
Current and Proposed Management				
Current and proposed management for fishless lakes	**Current Management** 29 lakes in the study area are currently fishless, including 3 in the national recreation areas and 26 in the national park.	**Proposed Management** 49 lakes in the study area would remain fishless or be actively returned to fishless conditions.	**Proposed Management** 80 lakes in the study area would remain fishless or be actively returned to fishless conditions; this includes 11 lakes in the national recreation areas and 69 lakes in the national park.	**Proposed Management** 91 lakes in the study area would remain fishless or be actively returned to fishless conditions.
Current and proposed management of lakes with high densities of reproducing fish	**Current Management** 27 lakes currently contain high densities of reproducing fish.	**Proposed Management** No lakes would contain high densities of reproducing fish.	**Proposed Management** No lakes would contain high densities of reproducing fish.	**Proposed Management** No lakes would contain high densities of reproducing fish.

TABLE ES-3: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Current and Proposed Management (continued)				
Current and proposed management of lakes with low-densities of fish (reproducing and nonreproducing)	**Current Management** 9 lakes currently contain low densities of reproducing fish.	**Proposed Management** 7 lakes would contain low densities of reproducing fish.	**Proposed Management** 1 lake in a national recreation area and no lakes in the national park would contain low densities of reproducing fish.	**Proposed Management** No lakes would contain low densities of reproducing fish.
Current and proposed management of lakes with nonreproducing fish	**Current Management** 26 lakes are currently stocked with nonreproducing fish.	**Proposed Management** 22 lakes would have nonreproducing fish.	**Proposed Management** 8 lakes in the national recreation areas would have nonreproducing fish. No lakes in the national park would be stocked.	**Proposed Management** No lakes would have fish.
Current and proposed management of lakes lacking data	**Current Management** No additional data would be needed to make final management action determinations.	**Proposed Management** 13 lakes would be evaluated under a new adaptive management framework prior to determining management action.	**Proposed Management** 2 lakes in the national recreation areas would be evaluated under a new adaptive management framework prior to determining management action.	**Proposed Management** No additional data would be needed to make final management action determinations.
Outcome of continuing current management framework or implementing proposed new adaptive management framework	**Current Management Outcome** Of the 91 lakes in the study area, **62** would continue to have fish **29** would remain fishless.	**Possible Future Outcome** Of the 91 lakes in the study area, **29** lakes would have fish **49** lakes would be fishless **13** lakes would be evaluated before determining management action.	**Possible Future Outcome** Of the 91 lakes in the study area, **9** lakes would have fish **80** lakes would be fishless **2** lakes would be evaluated before determining management action.	**Possible Future Outcome** Of the 91 lakes in the study area, **91** lakes would either remain fishless or become fishless over time
Implementation	The NPS would seek clarification from Congress as to whether stocking should be an accepted practice in the North Cascades Complex.	Same as alternative A.	Same as alternative A.	No congressional action would be necessary.

TABLE ES-3: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Current and Proposed Management (continued)				
Consistency with *NPS Management Policies* (NPS 2001a)	This alternative is not consistent with existing *NPS Management Policies* regarding fish stocking and the introduction of exotic species.	This alternative is not consistent with existing *NPS Management Policies* regarding fish stocking and the introduction of exotic species.	This alternative is consistent with existing *NPS Management Policies* regarding fish stocking and the introduction of exotic species into national recreation areas lakes.	This alternative is consistent with existing *NPS Management Policies* regarding fish stocking and the introduction of exotic species.
Fish species (and strains) stocked (under alternative A) or fish species (and strains) proposed to be stocked under alternatives B and C	• Golden Trout • Coastal Cutthroat Trout (Lake Whatcom Strain) • Rainbow Trout (Mt. Whitney Strain) • Rainbow Trout (Ross Lake Strain) • Westslope cutthroat trout (twin Lakes Strain	• Rainbow Trout (Mt. Whitney Strain) • Rainbow Trout (Ross Lake Strain) • Golden Trout	• Rainbow Trout (Mt. Whitney Strain)	No lakes would be stocked.
Current and proposed reproducing fish species (and strains) to be maintained under alternatives A, B, and C	• Rainbow Trout (Packwood Lane Strain) • Westslope Cutthroat Trout (Twin Lakes Strain) • Brook Trout • Coastal cutthroat Trout (Lake Whatcom Strain) • Yellowstone Cutthroat Trout	• Rainbow Trout (Strain unknown) • Westslope Cutthroat Trout (Strain unknown) • Golden Trout • Westslope Cutthroat Trout (Twin Lakes Strain) • Yellowstone Cutthroat Trout	• Westslope cutthroat trout (Twin Lakes Strain) • Westslope cutthroat (Unknown Strain)	Two lakes potentially would contain reproducing fish populations: • Westslope cutthroat trout (Twin Lakes Strain) • Westslope cutthroat (Unknown Strain)

TABLE ES-3: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Current and Proposed Management (continued)				
Fish hatchery locations	• Arlington Hatchery, Washington • Eells Springs Hatchery, Washington • Marblemount Hatchery, Washington • WDFW Bellingham Hatchery, Washington • WDFW Chelan Hatchery, Washington	Same as alternative A.	Same as alternative A.	No lakes would be stocked.
Stocking density	Stocking density varies from year to year; see table 6 for stocking density of the most recent stocking efforts.	Same as alternative A.	Same as alternative A.	No lakes would be stocked.
Specific times of year for stocking	Stocking occurs during the ice-free period, which varies from year to year, but on average is between mid-July to mid-September; stocking can occur as early as mid-May or as late as mid-October depending on weather conditions.	Same as alternative A.	Same as alternative A.	No lakes would be stocked.
Stocking methods (and performed by whom)	Fixed-wing aircraft (by WDFW). Backpack (by WDFW and volunteers from Trail Blazers, Inc.).	Same as alternative A.	Same as alternative A.	No lakes would be stocked.

TABLE ES-3: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Lake Treatments to Manage the Fishery				
Mechanical methods (using gill and fyke nets/electrofishing/ trapping/exclusion of habitat)	No mechanical methods are used to remove fish.	8 lakes	10 lakes	11 lakes
Chemical methods (using chemicals that kill fish)	No chemical methods are used to remove fish.	19 lakes	25 lakes	25 lakes
Natural methods (discontinue stocking)	No natural methods are used to remove fish.	12 lakes	21 lakes	26 lakes
Monitoring Program				
	Trail Blazers and Hi-Lakers perform periodic surveys. From 1968 to 2001, 133 anglers filed 90 reports for 31 lakes. Reports yield estimates of fish abundance, growth, and species composition, as well as angler effort, success, and usage. Continue monitoring macroinvertebrates and expand to include stocked lakes. WDFW would continue to collect data from Trail Blazers and Hi-Lakers. Continue monitoring visitor use. Data related to fishing would be useful in determining adaptive management, especially fish stocking.	Same as alternative A, with additional monitoring of • species assemblages in lakes with fish • visitor use relating to fishing • species assemblages and collecting of physical data needed before treating lakes for fish removal • recovery of species assemblages after treating lakes for fish removal	Same as alternative B.	Same as alternative B.

TABLE ES-3: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Mitigation				
	No mitigation occurs under alternative A.	Nonreproducing fish would be stocked to prevent establishment of reproducing, self-sustaining populations of fish. Reproduction would be limited by inducing genetic sterility or selecting hatchery strains that cannot reproduce due to spawning habitat limitations and/or timing of spawning limitations (e.g., Mount Whitney rainbow trout). For lakes with no spawning habitat, fish native to the surrounding watershed (e.g., Ross Lake rainbow trout in the Skagit River basin) would be stocked. Over the long term, the WDFW would also work toward creating hybrid, sterile hatchery strains to further minimize the risks of in-lake reproduction and downstream dispersal and hybridization with native fish. Where applicable, stocking would be rotated to allow resting periods so native species could recover. Stocking methods could be limited to horse or backpack to limit impacts on other park visitors. Protocols for fish removal would be strictly enforced to avoid impacts on other species and on worker and visitor safety (see appendix I).	Same as alternative B.	Same as alternative B.
Cost of Implementation				
	Approximately $270,000 over the next 15 years.	Approximately $2.14 million over the next 15 years.	Approximately $2.84 million over the next 15 years.	Approximately $3 million over the next 15 years.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Aquatic Organisms				
	Aquatic organisms (including plankton, macroinvertebrates, and amphibians) would continue to experience long-term negligible to minor adverse impacts from fish predation and competition in lakes stocked with low densities of nonreproducing fish. In lakes with high densities of reproducing fish, certain plankton and macroinvertebrates would continue to experience long-term moderate to major adverse impacts from intensive predation and competition. Long-term minor to moderate adverse impacts on amphibians would continue in lakes with reproducing populations of fish, limited refugia, relatively high nutrient (for example, high total Kjeldahl nitrogen) availability, and limited lake connectivity to other water bodies with suitable amphibian habitat. Long-term moderate to major adverse impacts from hybridization between native and nonnative fish would continue to persist. Short- and long-term adverse cumulative impacts on aquatic organisms would vary widely depending upon trends in aquatic ecosystem stressors such as air pollution, development in surrounding watersheds, and climate change. Overall, the cumulative impacts associated with other actions in the area, added to the impacts predicted under alternative A, would result in short- and long-term minor to	Impacts on aquatic organisms in lakes stocked with low densities of nonreproducing fish would be the same as alternative A, except these impacts would decline further in the future as stocking is curtailed or eliminated in lakes based upon adaptive management decisions pertaining to stocking. Removal of reproducing populations of fish from select lakes would eventually result in long-term beneficial effects on aquatic organisms in those lakes; however, removal of reproducing fish populations would take many years. Until fish are removed, minor to major impacts on aquatic organisms would persist as described in alternative A. Mechanical methods of fish removal (netting, trapping, spawning habitat exclusion) would have short-term negligible to minor adverse impacts on aquatic organisms. Chemical methods of fish removal (application of the piscicide antimycin) would have short-term negligible to moderate adverse impacts on certain aquatic organisms. Compared to alternative A, the risk of hybridization would decline over the long term as reproducing populations of fish are removed, and fewer nonnative fish dispersed downstream from lakes. The risk of hybridization, however, would not be entirely eliminated primarily because reproducing populations of nonnative fish are now present in many	Impacts on aquatic organisms would be similar to alternative B except impacts would only occur in national recreation area lakes that would continue to be stocked with low densities of nonreproducing fish. Removal of reproducing populations of fish from lakes in the national park portion of the North Cascades Complex would have the same effects on aquatic organisms as under alternative B. Impacts of mechanical and chemical methods of fish removal would be the same as under alternative B. Impacts on native fish from hybridization between native and nonnative fish would be the same as under alternative B. Compared to alternative A, there would be a long-term beneficial cumulative impact on populations of native aquatic organisms because a minimum of 51 lakes (all lakes in the national park unit and select national recreation area lakes) would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would be similar to alternative B. Impairment of aquatic organisms across the study area would not occur under alternative C.	Compared to alternative A, long-term beneficial impacts would occur to aquatic organisms as lakes are returned to a fishless condition. Once stocked fish were gone, native aquatic communities would eventually revert to predisturbance (that is, prestocking) conditions, and this would result in long-term beneficial impacts on native aquatic organisms. Removal of reproducing populations of fish from all study area lakes in the North Cascades Complex would have the same effects on aquatic organisms as under alternative B. Impacts of mechanical and chemical methods of fish removal would be the same as under alternative B. Impacts on native fish from hybridization between native and nonnative fish would be the same as under alternative B. Compared to alternative A, there would be a long-term beneficial cumulative impact on populations of native aquatic organisms because all study area lakes in the North Cascades Complex would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would be similar to alternative B. Impairment of aquatic organisms across the study area would not occur under alternative D.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Aquatic Organisms (continued)				
	potentially major adverse impacts on plankton, macroinvertebrates, and amphibians, and/or certain species of native fish in individual lakes in the study area but with overall minor to moderate adverse impacts for the region. Impairment of aquatic organisms across the study area would not occur under alternative A.	drainages throughout the North Cascades Complex. Impacts over the long term would be minor to moderate and adverse. Compared to alternative A, there would be a long-term beneficial cumulative impact on native aquatic organisms because a minimum of 20 lakes would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would be similar to alternative A. Impairment of aquatic organisms across the study area would not occur under alternative B.		
Wildlife				
	The historic and current stocking of fish created suitable conditions for piscivorous wildlife, such as fish-eating ducks, while potentially restricting populations of other species, such as amphibians, that are prey for several wildlife species. Impacts from activities associated with periodic fixed-wing aircraft stocking (noise disturbance) and backpack stocking (human presence and habitat trampling) under alternative A would be short term, negligible to minor, and adverse on wildlife at or near the lakes. Animals that roost or dwell further away from lakes, such an ungulates, bats, rodents, and many forest-dwelling birds, would incur short-term, negligible, adverse impacts or no impacts from stocking activities.	Removal of fish would result in the loss of a food source for fish-eating species, requiring them to disperse to other areas in search of resources; because of this, piscivorous wildlife would incur long-term negligible to minor adverse impacts when lakes are returned to fishless conditions. Impacts from stocking activities would be similar to alternative B, except the number of lakes stocked would decrease under alternative B. Mechanical and chemical treatment methods used to remove fish under alternative B would result in short-term negligible to minor adverse impacts on wildlife, with short-term disturbance to birds and mammals that inhabit the lake and shoreline from the noise of human	Impacts on fish-eating species from removal of fish would be similar to alternative B. Impacts from stocking activities would be similar to alternative B, except the number of lakes stocked would substantially decrease under alternative C. Impacts from mechanical and chemical treatment methods would be the same as alternative B. Cumulative impacts would be similar to alternative A. Impairment of wildlife species across the study area would not occur under alternative C.	Alternative D would have long-term, minor to moderate adverse impacts on fish-eating wildlife in lakes that would become fishless. Removal of fish would result in the loss of habitat for fish-eating species, requiring them to relocate to other areas (potentially outside the North Cascades Complex) in search of resources, which would result in local population decreases for those species, returning the area to pre-stocked conditions. Under alternative D, stocking activities would be eliminated, a benefit to wildlife that would be disturbed by the noise and human disturbance associated with stocking activities.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Wildlife (continued)				
	None of the 91 lakes are currently treated for fish removal under alternative A; therefore, wildlife in or near the lakes would not incur impacts from lake treatments. The impacts associated with other projects and fishery management actions in the area plus impacts from potential airborne pollution, added to the impacts predicted under alternative A, would result in long-term minor adverse cumulative impacts on wildlife populations and communities in the region. Impairment of wildlife species across the study area would not occur under alternative A.	presence and helicopters used to transport equipment for mechanical treatment. Cumulative impacts would be similar to alternative A. Impairment of wildlife species across the study area would not occur under alternative B.		Impacts of treatment methods would be the same as alternative B. Cumulative impacts would be the same as under alternative A. Impairment of wildlife species across the study area would not occur under alternative D.
Special Status Wildlife Species				
	Based on available information, fixed-wing aircraft noise and human disturbance associated with periodic fish-stocking activities under alternative A would have a range of short-term negligible to minor effects on special status wildlife species. Fish removal does not occur under alternative A, so there would be no impacts on special status wildlife species from lake treatments to remove fish.	Fish-stocking activities under alternative B would have a range of short-term negligible to minor effects on some special status wildlife species but would be reduced from the effects that would occur under alternative A. The use of the chemical, antimycin, to remove fish is not known to have adverse impacts on amphibians. There would be long-term beneficial effects on some aquatic species because most high-density reproducing populations of fish would be replaced with low-density nonreproducing stocked fish.	Fish-stocking activities under alternative C would have a range of short-term negligible to minor effects on some special status wildlife species but would be reduced from the effects that would occur under alternatives A and B. Short-term impacts related to lake treatments to remove fish would be minor, mostly due to noise from helicopters transporting lake treatment equipment and human disturbance during treatment activities. Impacts from the use of antimycin to remove fish would be the same as under alternative B.	All fish stocking would be discontinued under alternative D. Short-term impacts related to lake treatments to remove fish would be minor, mostly due to noise from helicopters transporting lake treatment equipment and human disturbance during treatment activities. Impacts from the use of antimycin to remove fish would be the same as under alternative B.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Special Status Wildlife Species (continued)				
	Based on the available information, alternative A would have ***no adverse effects on federally listed species*** from fish stocking. Regarding ***federally listed species:*** **21 species may be affected but are not likely to be adversely affected** (American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, marbled murrelet, Northern goshawk, Northern spotted owl, Pacific fisher, Yuma myotis, long-eared bat, bald eagle, harlequin duck, little willow flycatcher, olive-sided flycatcher, Cascades frog, Columbia spotted frog, northern red-legged frog, bull trout, Chinook salmon, Coho salmon). **2 species would incur no effect** (tailed frog and Western toad). **1 species may be affected and is likely to be adversely affected** (westslope cutthroat trout)—effects would be limited to one drainage downstream from McAlester Lake as a result of documented hybridization and colonization. Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts (solely from noise related to stocking activities), and the common loon would incur short-term negligible adverse impacts. Continuation of stocking would provide beneficial effects by	Based on the available information, alternative B would have ***no adverse effects on federally listed species*** from fish stocking or lake treatments to remove fish. Regarding ***federally listed species:*** **23 species may be affected, but are not likely to be adversely affected:** Same as A, with the addition of the Western toad, and western cutthroat trout. **1 species would incur no effect** (tailed frog). Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts from noise related to stocking and lake treatment activities, and the common loon would incur long-term minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake. Cumulative impacts would be the same as under alternative A. Impairment of special status wildlife species across the study area would not occur under alternative B.	Based on the available information, alternative C would have ***no adverse effects on federally listed species*** from fish stocking or lake treatments to remove fish. Regarding ***federally listed species:*** **23 species may be affected, but are not likely to be adversely affected:** Same as alternative B. **1 species would incur no effect** (tailed frog). Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts from noise related to stocking and lake treatment activities, and the common loon would incur long-term minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake. Cumulative impacts would be the same as under alternative A. Impairment of special status wildlife species across the study area would not occur under alternative C.	Based on the available information, alternative D would have ***no adverse effects on federally listed species*** from lake treatments to remove fish. Regarding ***federally listed species:*** **22 species may be affected, but are not likely to be adversely affected** (American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, little willow flycatcher, marbled murrelet, Northern goshawk, Northern spotted owl, olive-sided flycatcher, Pacific fisher, Yuma myotis, long-eared bat, bald eagle, harlequin duck, Cascades frog, Columbia spotted frog, northern red-legged frog, Western toad, bull trout, Chinook salmon, Coho salmon, and westslope cutthroat trout). **2 species would incur no effect** (Cascades frog and tailed frog). Regarding ***state-listed species that are not federally listed***, 6 species would incur negligible to minor adverse impacts from noise related to fish removal activities, and the common loon would incur minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake. Cumulative impacts would be the same as under alternative A. Impairment of special status wildlife species across the study area would not occur under alternative D.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Special Status Wildlife Species (continued)				
	supporting an adequate food base for nesting loons near Hozomeen Lake and other stocked lakes. Cumulative impacts on each special status species from projects or actions occurring throughout the region would be adverse; however, alternative A would contribute only a small increment to overall cumulative impacts. Impairment of special status wildlife species across the study area would not occur under alternative A.			
Special Status Plant Species				
	Fish-stocking activities at lakes with shoreline meadow or shrub vegetation would have short-term negligible to minor adverse impacts on any special status plants in the shoreline areas of lakes in cross-country zones or near camps with low visitor use. Stocking activities at lakes in zones or near camps with medium to high visitation would result in short-term negligible to major adverse impacts on any special status plants. No lakes are treated for fish removal under alternative A. Trampling by stock (horses, mules, llamas) and visitors (anglers and other visitors) would likely result in minor to moderate cumulative impacts at some lakes and moderate to major at others, depending on the intensity of use and location of sensitive plants.	Fewer lakes would be stocked under alternative B. Trampling during stocking activities may result in negligible to minor adverse impacts at lakes in cross-country zones or near camps that have low visitor use and negligible to moderate adverse impacts on any special status plants that may be present in the shoreline of lakes that are in zones or near camps that receive medium to high use. There would long-term beneficial effects on special status plant species at lakes where stocking would not occur. Select lakes would be treated for fish removal under alternative B. Trampling during mechanical and chemical lake treatment activities may result in short-term negligible to minor adverse impacts on any special status plants that may be present in the shoreline of lakes that are in cross-country zones or near camps	Impacts from stocking activities would be similar to alternative B, except that with considerably fewer lakes stocked, impacts would be reduced to negligible to minor and adverse over the long term. Impacts from mechanical and chemical lake treatment activities to remove fish would be similar to alternative B, although a higher number of lakes would be treated for fish removal under alternative C than under alternative B. Cumulative impacts would be similar to alternative B, except as fish stocking is eliminated in the park, impacts would be reduced to negligible over the long term. Impairment of special status plant species across the study area would not occur under alternative C.	Fish stocking would not occur under alternative D, which would result in long-term beneficial effects on special status plant species. Mechanical and chemical lake treatment activities to remove fish would result in impacts similar to alternative B. Cumulative impacts would be the same as under alternative C. Impairment of special status plant species across the study area would not occur under alternative D.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Special Status Plant Species (continued)				
	Impairment of special status plant species across the study area would not occur under alternative A.	that receive medium to high visitor use, and negligible to minor adverse impacts at lakes in zones or near camps that have low visitor use. Cumulative impacts would be similar to alternative A but would be reduced as fish are removed from lakes. Impairment of special status plant species across the study area would not occur under alternative B.		
Vegetation				
	Fifty-nine of the 62 lakes in the study area where fishing would continue have meadow and/or shrub vegetation. Of these, about 75% have low to medium visitation, and vegetation would experience only negligible impacts. The remaining 25% that have high visitation would continue to experience long-term minor to moderate adverse impacts from trampling. Forest shoreline vegetation would generally not be affected more than a negligible or minor level from visitor use, including angling. Cumulative impacts would be negligible to moderate and adverse over the long term. Impairment of vegetation across the study area would not occur under alternative A.	Twenty-nine of the 35 lakes in the study area where fishing would continue have meadow vegetation that is sensitive to trampling. Eleven of the 29 lakes are within cross-country zones or near camps that would continue to experience low visitor use, with resulting negligible to minor adverse impacts. Eighteen of the 29 lakes are within cross-country zones or near camps that would continue to experience medium to high visitor use, and vegetation would experience negligible to moderate impacts. In addition to the 29 lakes that are currently fishless in alternative A, alternative B would return 20 lakes to a fishless condition with possible negligible to moderate benefits to shoreline meadow vegetation over time. Temporary negligible to moderate adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatments would occur, and continued fishing as a means of natural removal would have	Alternative C would provide substantial long-term benefits to meadow and sensitive forest vegetation from the return of 51 additional lakes to fishless conditions compared to alternative A. The majority of these lakes have meadow vegetation, and 29 of the 51 lakes are located in cross-country zones or near camps that receive a medium to high level of use. To the extent this use is attributable to fishing and fishing-related stock use, benefits to vegetation would occur at these lakes. Of the 9 lakes where fishing would continue, 6 are in cross-country zones or near camps that experience light use now, which would most likely continue to have negligible adverse impacts on vegetation. Three lakes are in cross-country zones or near camps that would continue to experience medium or high use, with resulting negligible to moderate adverse impacts on meadow vegetation. One lake may continue to experience minor or even moderate impacts on	Under alternative D, 62 additional lakes would be returned to fishless conditions compared to alternative A. Vegetation at these lakes would experience overall beneficial impacts. The degree of benefit would range from negligible to moderate and would depend on the level of visitor use, access, sensitivity of the vegetation, and other factors. The majority of these lakes have meadow vegetation. If high visitor use, stock use, and trail use are related to fishing, a decline in fishing opportunity would offer substantial benefits to this more sensitive vegetative community. Temporary negligible or minor adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatment would occur, and continued fishing as a means of natural removal would have short-term negligible to moderate adverse impacts. Adverse cumulative impacts would be negligible to moderate and long term.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Vegetation (continued)				
		short-term negligible to moderate adverse impacts. Adverse cumulative impacts would be negligible to moderate and long term. Impairment of vegetation across the study area would not occur under alternative B.	shoreline forest vegetation. Temporary negligible or minor adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatment would occur, and continued fishing as a means of natural removal would have short-term negligible to moderate adverse impacts. Adverse cumulative impacts would be negligible to moderate and long term. Impairment of vegetation across the study area would not occur under alternative C.	Impairment of vegetation across the study area would not occur under alternative D.
Cultural Resources				
	Alternative A would not change the number of lakes for fishing or the number of anglers using them over the long term. Potential adverse impacts of unknown intensity on archeological resources would be mitigated to negligible to minor. Mitigation would also help keep impacts on historic structures from exceeding minor levels. Potential impacts on cultural landscapes would be mitigated to no greater than minor. No impacts on ethnographic resources are anticipated. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources. Adverse cumulative impacts would range from negligible to minor over the long term.	Possible impacts on archeological resources that would result from preparation of mechanical fish removal equipment and helicopter use (and associated landing pads adjacent to lakes) to transport the equipment would be mitigated to negligible to minor through survey and monitoring prior to use. Possible adverse impacts on historic structures are of unknown magnitude but would not likely exceed negligible to minor. Potential impacts on identified cultural landscapes would be mitigated to no greater than minor. The temporary water-quality degradation from chemicals used to remove fish would potentially result in adverse impacts of unknown intensity on ethnographic resources used by Native Americans for traditional purposes. Such impacts would be	The impact of reduced sport-fishing opportunities would result in negligible impacts on archeological resources in general, with beneficial effects as a result of the return of one lake identified as sensitive to a fishless state. Adverse impacts on historic structures are likely to be negligible; the elimination of fishing at one particularly sensitive lake would result in a benefit to historic structures. Cultural landscapes in the study area may incur no greater than minor adverse impacts; in one case, a benefit to the resources would be realized. Impacts on ethnographic resources would likely be mitigated to negligible. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources.	Under alternative D, the long-term effects of elimination of fishing at all of the mountain lakes in the study area would result in reduced human fishing activity, a benefit to archeological resources in the North Cascades Complex. More specifically, those lake and trail areas identified as sensitive regarding cultural resources would incur benefits by way of reduced risk of disturbance. Adverse impacts on cultural landscapes would likely be negligible; minor benefits may be realized at one designated cultural landscape where fishing would be eliminated. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Cultural Resources (continued)				
	Impairment of cultural resources across the study area would not occur under alternative A.	mitigated to negligible through an agreement with the NPS, affected Tribes, and the State Historic Preservation Office regarding the timing of management activities and locations of specific areas that should be avoided. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources. Adverse cumulative impacts would range from negligible to minor over the long term. Impairment of cultural resources across the study area would not occur under alternative B.	There would be beneficial cumulative impacts for cultural resources from reduced human activity at a number of mountain lakes. Impairment of cultural resources across the study area would not occur under alternative C.	Cumulative impacts would be beneficial. Impairment of cultural resources across the study area would not occur under alternative D.
Visitor Use and Experience				
Recreational Use	Impacts on non-anglers under alternative A would primarily be related to noise and disruption from fixed-wing aircraft stocking activities. Such adverse impacts would be negligible and temporary but would continue over the long term as stocking activities continue. Anglers would experience long-term beneficial impacts because they would continue to enjoy fishing activities unchanged from the past. Cumulative impacts would result from the partial loss of the Stehekin Valley Road due to flooding that occurred in the fall of 2003. The fate of the road is currently uncertain. If the road is not repaired, then access to backcountry portions of the Stehekin	Adverse impacts on non-anglers under alternative B would primarily be related to lake treatment methods. These impacts would be negligible to minor adverse over the long term. Removal of fish from some lakes would reduce visitor use and have some long-term beneficial impacts on non-anglers seeking greater solitude in the backcountry. Impacts on most anglers overall would be minor to moderate, adverse, and long term from management actions under alternative B compared to alternative A. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere.	Same as alternative B. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere.	Same as alternative B. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere. Overall, cumulative impacts would be moderate, adverse, and long term. The cumulative impact of reduced access in the Stehekin Valley due to flood damage would be minor adverse or beneficial to backcountry users.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Visitor Use and Experience (continued)				
Recreational Use (continued)	Valley may be more difficult, and this would reduce the amount of backcountry visitation. Some visitors might enjoy the increased solitude and wilderness setting, while others might lament the reduced access to backcountry areas in the Stehekin Valley, including fishable lakes. Therefore, adverse cumulative impacts on visitor use would be minor to moderate over the long term.	Cumulative impacts related to angler displacement to overused areas outside the North Cascades Complex would overall be minor to moderate, adverse, and long term. The cumulative impact of reduced access in the Stehekin Valley due to flood damage would be minor adverse or beneficial to backcountry users.		
Social Values	Continuation of existing management actions under alternative A would have a beneficial effect on the social values of anglers and angler groups because stocking and sport fishing would not change. Impacts on social values of conservationists and conservation groups would be long term, moderate to major, and adverse. Continuation of management actions as described in alternative A would not alter angler use; therefore, cumulative impacts on social values of anglers would be long term and beneficial. Continuation of management actions as described in alternative A would have a moderate to major adverse cumulative impact on conservationists and conservation groups.	Alternative B would have a minor adverse impact on the social values of anglers and angler groups over the long term because some level of stocking and sport fishing would continue over the long term. Impacts on social values of conservationists and conservation groups would be beneficial for some who would support the new management framework but moderate to major adverse and long term for those who oppose any stocking of lakes over the long term. Alternative B would have a moderate to major adverse cumulative impact on conservationists and conservation groups, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts on anglers and angling groups would be moderate to major, adverse, and long term, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts related to flood damage to upper Stehekin Valley Road would be minor to moderate, adverse, and long term.	Alternative C would have a moderate to major adverse impact on the social values of anglers and angler groups over the long term because sport fishing would eventually be eliminated in the national park, and many anglers and angler groups believe that fishing in the park is a unique opportunity that cannot be duplicated elsewhere. Impacts on social values of conservationists and conservation groups would be the same as under alternative B. Cumulative impacts would be the same as under alternative B.	Alternative D would have a moderate to major adverse impact on the social values of anglers and angler groups over the long term, especially for those who use and value the park for this experience. Anglers may choose to pursue sport fishing outside the North Cascades Complex. Overall, impacts on social values of conservationists and conservation groups would be beneficial. Cumulative impacts would be the same as under alternative B.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Visitor Use and Experience (continued)				
Wilderness Values	Backpack stocking would have a short- and long-term negligible direct impact on visitor solitude. Given the brief and infrequent nature of fixed-wing aircraft stocking, there would be a short- and long-term minor adverse impact on opportunities for solitude. Sport-fishing opportunities would remain at current levels. This would result in long-term negligible impacts on opportunities for solitude for those areas that receive relatively little use, and would result in long-term minor adverse impacts on opportunities for solitude for those areas that receive high use. Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be long-term minor to moderate and adverse. Those with an anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience negligible long-term impacts under alternative A. Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience major, long-term adverse impacts by the continued fishery management practices under alternative A. Impacts on wilderness users who are unaware that fish are present in the lakes would be negligible over the long term. Cumulative impacts on fishing opportunities in mountain lakes from	Backpack and fixed-wing aircraft stocking would result in impacts similar to alternative A, except fewer lakes would be stocked. Fishery management actions would reduce sport-fishing opportunities compared to alternative A. This would result in a long-term minor beneficial impact on opportunities for solitude in some areas. However, some lakes in certain high-use areas would remain fishable, resulting in minor adverse impacts on opportunities for solitude over the long term. The impacts on solitude from fish removal activities would be minor to moderate and adverse over the long term. Anglers who choose to fish elsewhere due to the reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience long-term major adverse impacts. Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be minor to moderate adverse over the long term. Those with anthropocentric perspective would experience negligible long-term impacts under alternative B. Those with an anthropocentric perspective may view the application of a science-based adaptive management plan as a negligible impact, and some may view this as beneficial. Those with strong biocentric views of wilderness would experience long-term major	Backpack and fixed-wing aircraft stocking would result in impacts similar to alternative A, except to a lesser degree because fewer lakes would be stocked, and these lake would only be in the national recreation areas. Fishery management actions would reduce sport-fishing opportunities compared to alternatives A and B. Sport-fishing opportunities would be eliminated in national park lakes but would continue to exist in select national recreation area lakes. This would result in a long-term moderate beneficial impact on opportunities for solitude in some areas. However, some lakes in certain high-use areas would remain fishable, resulting in long-term minor adverse impacts on opportunities for solitude. Impacts on solitude from fish removal activities would be long term minor to moderate and adverse. Anglers who choose to fish elsewhere due to the reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience major adverse long-term impacts. Impacts on visitor opportunities for primitive recreation in high-use areas over the summer would be long term minor to moderate and adverse. Those with an anthropocentric perspective would experience long-term moderate adverse impacts under alternative C due to the loss of	Sport-fishing opportunities would be vastly reduced compared to alternative A because all stocking in the North Cascades Complex would cease, and fish would be removed from all lakes, where feasible. This would result in long-term moderate to major beneficial impacts on opportunities for solitude in areas where fishing opportunities are eliminated. However, fishing opportunities would continue to exist in the nine deep lakes where complete fish removal may not be feasible, resulting in long-term minor adverse impacts on opportunities for solitude. Impacts on solitude from fish removal activities would be minor to moderate and adverse over the long term. Anglers who choose to fish elsewhere due to reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience long-term major adverse impacts. The cessation of anglers using wilderness would result in long-term beneficial impacts on other visitors. Those with an anthropocentric perspective would experience long-term major adverse impacts. Those with an anthropocentric perspective may view the application of a science-based adaptive management plan to remove fish as a negligible impact, and some would view this as beneficial.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Visitor Use and Experience (continued)				
Wilderness Values (continued)	reduced access would likely be negligible over the short and long terms. There would be a long-term major adverse cumulative impact on those who believe that continued stocking and continued presence of reproducing fish populations under alternative A would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and enjoyment of wilderness should continue.	adverse impacts from fishery management actions under alternative B. Some with biocentric perspectives would view the application of a science-based adaptive management plan as beneficial over the long term. Impacts on wilderness users who are not aware that fish are present in the lakes would be negligible over the long term. Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms. There would be a long-term major adverse cumulative impact on those who believe that the continued stocking (as proposed under alternative B) in wilderness and continued presence of reproducing populations of fish would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles in wilderness areas, cumulative impacts would be long term beneficial or adverse. Fishery management actions, including fish removal, would have a minor adverse cumulative impact on solitude over the long term.	fishable lakes in the national park; however, fishing opportunities would still remain in wilderness areas in select national recreation area lakes. Those with an anthropocentric perspective may view the application of a science-based adaptive management plan as a negligible impact, and some may view this as beneficial over the long term. Those with strong biocentric views of wilderness would experience long-term major adverse impacts from the fishery management actions under alternative C. Some with biocentric perspectives may view the application of a science-based adaptive management plan as beneficial over the long term. Impacts to wilderness users who are not aware that fish are present in the lakes would be negligible over the long term. Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms. There would be a long-term major adverse cumulative impact on those who believe that the stocking proposed under alternative C and continued presence of reproducing populations of fish would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and	Those with strong biocentric views of wilderness would experience major long-term beneficial impacts because all fish would be removed (where feasible) under alternative D. Some with a biocentric perspective may view the application of a science-based adaptive management plan as beneficial over the long term. Impacts to those wilderness users who would not be aware that nonnative fish have been removed from the lakes would be negligible over the long term. Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms. There would be major long-term beneficial cumulative impacts on those who believe that continued stocking in wilderness and continued presence of reproducing populations of fish would compromise natural processes. There would be long-term major adverse cumulative impacts on anglers who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles to remove fish from wilderness areas, cumulative impacts either would be beneficial or adverse over the long term. Fishery management actions, including fish removal, would have minor adverse cumulative impacts on solitude over the long term. Due to the cessation of

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Visitor Use and Experience (continued)				
Wilderness Values (continued)			enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles in wilderness areas, cumulative impacts either would be beneficial or adverse over the long term. Fishery management actions, including fish removal, would have a long-term minor adverse cumulative impact on solitude. Due to the cessation of stocking in national park lakes, long-term moderate beneficial cumulative impacts on wilderness values would be expected.	stocking, moderate to major beneficial cumulative impacts on wilderness values would be expected over the long term. The displacement of anglers to other wilderness areas would result in negligible adverse cumulative impacts, even if all anglers decided to fish elsewhere.
Human Health				
	Alternative A would have negligible impacts on human health over the long term from the consumption of stocked fish that may have been exposed to persistent organic pollutants and methyl-mercury, and no adverse impacts on human health from any lake treatment chemicals since none would be used. Cumulative impacts on human health would be negligible adverse over the long term.	Impacts from stocking decisions and consumption of stocked fish would be the same as alternative A. Proposed chemical treatments that would be used to remove fish from 19 lakes would have long-term negligible adverse impacts on human health. Cumulative impacts on human health would be negligible to minor adverse over the long term.	Impacts from stocking decisions and consumption of stocked fish would be the same as alternative A. Impacts from the proposed chemical treatment of 25 lakes would be the same as alternative B. Cumulative impacts on human health would be the same as alternative B.	Impacts from consumption of fish from previously stocked lakes would be the same as alternative A. Impacts from the proposed chemical treatment of 25 lakes would be the same as alternative B. Cumulative impacts on human health would be the same as alternative B.

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Socioeconomic Resources				
	Alternative A would have long-term negligible impacts on the local and regional economies. Estimated revenues from mountain lake angling account for roughly $1 out of every $100,000 spent in the three-county region. The effects of continuation of the current fishery management program on some local businesses in the Stehekin area would be beneficial since some patrons may also engage in sport fishing in the mountain lakes located in Lake Chelan National Recreation Area. Expenditures associated with sport fishing in the mountain lakes in the North Cascades Complex would continue to have long term negligible cumulative impacts on the local and regional economies.	Similar to alternative A but with potential long-term major adverse impacts on a limited number of businesses in Stehekin due to reduced fishing opportunities in mountain lakes. Cumulative impacts would be similar to alternative A.	Similar to alternative B, except that anglers who no longer would have fishing opportunities in high mountain lakes in the national park may choose to fish in the national recreation areas. This would have a beneficial long-term impact on local businesses in Stehekin. However, if the number of anglers choosing to fish in the mountain lakes in the recreation areas substantially decrease, there would be a long-term major adverse impact on some businesses in Stehekin. Cumulative impacts on the local and regional economies overall would be long term and negligible, while some businesses in Stehekin may experience long-term major adverse impacts because other visitor uses are not expected to increase substantially. There would be beneficial economic impacts on Stehekin area businesses if anglers chose to fish in the Lake Chelan National Recreation Area because fishing in the mountain lakes outside of the national recreation areas would be eliminated.	Overall, the local and regional economies would experience long-term negligible to minor adverse impacts from the elimination of sport fishing in the mountain lakes in the study area. Compared to alternative A, some Stehekin businesses would experience long-term major adverse impacts under alternative D if their primary source of income is from anglers who fish in the study area lakes. Overall, cumulative impacts would be long term, negligible, and adverse.
Management and Operations				
	Alternative A would have a negligible to minor adverse impact on management and operations over the long term. Total implementation costs would be $270,000 over a 15-year period and would primarily be borne by the WDFW. Average annual costs would be approximately $18,000 per year.	Alternative B would have moderate adverse impacts on management and operations over the long term, assuming all sources of funding remain fairly constant. Total implementation costs would be approximately $2.14 million over the next 15 years. Average annual costs for implementation are projected at	Alternative C would have similar moderate adverse impacts on management and operations as alternative B over the long term. Total implementation costs would be approximately $2.84 million over the next 15 years. Average annual costs would be similar to alternative B, but	Alternative D would have moderate adverse impacts on management and operations over the long term, assuming all funding sources remain fairly constant. Total cost of implementing alternative D would be approximately $3 million over the next 15 years. Average annual costs

TABLE ES-4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

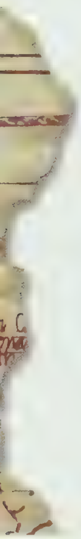
Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Management and Operations (continued)				
	Cumulative impacts would be negligible to minor and adverse over the long term.	approximately $112,100 for the first three years. As experience is gained conducting lake treatment and management, the number of lakes treated increases, raising costs to nearly $150,000 per year. Future stocking would be funded and implemented by the WDFW. However, should a long-term increase in NPS base funding for fishery management become available, implementing alternative B would have negligible to minor adverse impacts over the long term. Other sources of funding would be sought to reduce impacts on the park's operating budget. Cumulative adverse impacts on operations could arise from the need to respond to future unanticipated events such as flooding, wildfire, or other events. However, the magnitude of adverse impacts may range from negligible to major depending on the severity of individual future events, which could reduce the amount of potential funding available to implement the fishery management plan or cause the NPS to shift priorities to respond to more pressing needs.	the additional lakes targeted for fish removal would increase the total cost. Future stocking would be funded and implemented by WDFW. Similar to alternative B, if a long-term increase in NPS base funding becomes available, adverse impacts would become minor. Other sources of funding would be sought to reduce impacts on the park's operating budget. Cumulative impacts would be the same as alternative B.	for fish removal would be similar to alternative C. Although there are no average annual costs associated with fish stocking, the additional costs of protection required to prevent unsanctioned stocking of lakes would increase total implementation costs. Other sources of funding would be sought to reduce impacts on the park's operating budget. Cumulative impacts would be the same as alternative B.

Canada
Mt. Baker Wilderness
Mt. Shuksan
North C
Nationa
(north
Baker Lake
Skagit River
Marblemount
Sauk River
Suiattle River
Darrington
Boulder River Wilderness
0
5
10
20

Table of Contents

Welcome

This *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* is organized by the chapters listed below. Each of the chapters has its own "mini" table of contents on the back of the corresponding divider page to give you an idea how the chapter is organized.



Purpose of and Need for Action

Alternatives

Affected Environment

Environmental Consequences

Consultation and Coordination

References

Glossary, Acronyms, and Index

CONTENTS

PURPOSE OF AND NEED FOR ACTION

INTRODUCTION 3

PURPOSE OF AND NEED FOR ACTION 3

Purpose of the Plan 3
Need for Action 4

OBJECTIVES IN TAKING ACTION 5

PROJECT SITE LOCATION 6

BACKGROUND 10

ADMINISTRATIVE BACKGROUND 10

History of Fish Management in North Cascades Mountain Lakes 10
User Groups' Involvement in North Cascades Complex Fishery Management 14

SUMMARY OF EXISTING RESEARCH 15

SCOPING PROCESS AND PUBLIC PARTICIPATION 24

ISSUES AND IMPACT TOPICS 24

Aquatic Organisms 24
Other Wildlife 25
Special Status Species 26
Vegetation 26
Cultural Resources 27
Visitor Use and Experience 27
Human Health 28
Socioeconomic Resources 28
North Cascades Complex Management and Operation 28

ISSUES DISMISSED FROM FURTHER CONSIDERATION 29

Minority and Low-Income Populations 29
Floodplains 29
Special Status Species 29
Visitor Safety 29
Prime and Unique Agricultural Lands 29

RELATED LAWS, POLICIES, PLANS, AND CONSTRAINTS 30

GUIDING LAWS AND POLICIES 30

NPS Organic Act of 1916 30
NPS Management Policies (2001) 31
Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision Making and Handbook 33
North Cascades National Park Service Complex Enabling Legislation 33
Purpose and Significance of North Cascades National Park Service Complex 34

PLANNING DOCUMENTS FOR NORTH CASCADES NATIONAL PARK SERVICE COMPLEX 37

General Management Plan 37
Strategic Plan 37
Resource Management Plan 38

MANAGEMENT IN WILDERNESS 38

Washington Parks Wilderness Act and the Wilderness Act of 1964 38
Wilderness Management Plan 39

RELATED LEGISLATION AND POLICIES 39

Washington State Environmental Policy Act 39
Washington Department of Fish and Wildlife Goals, Policies, and Objectives 40
Statewide Fish Policy 40
Statewide Fishing Regulations 40

OTHER FEDERAL AGENCY PLANS, POLICIES, AND ACTIONS 41

U.S. Forest Service 41
U.S. Fish and Wildlife Service 41
National Marine Fisheries Service 41
Local Plans and Policies 43
Tribal Government Interests 43

ALTERNATIVES

INTRODUCTION 47

STUDY AREA DEFINITION 48

ALTERNATIVES DEVELOPMENT PROCESS 49

OVERVIEW OF ALTERNATIVES 49

REVIEW OF EXISTING DATA 50

APPLICATION OF RESEARCH 50

DEVELOPMENT OF MANAGEMENT ACTIONS FOR ALTERNATIVES B AND C 54

MANAGEMENT ACTIONS 64

ALTERNATIVE A: NO ACTION—EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH) 72

GENERAL CONCEPT 72

IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION 73

MINIMUM REQUIREMENTS 75

CURRENT FISHERY MANAGEMENT PROGRAM 76

Current Management Framework 76
Current Stocking Program 76

Current Lake Treatments to Manage the Fishery 79
Current Mitigation 80
Current Monitoring Program 80
Cost of Implementation 81

ELEMENTS COMMON TO ALL ACTION ALTERNATIVES 82

MANAGING NORTH CASCADES AS A COMPLEX, AS OPPOSED TO DISCRETE UNITS 82

MONITORING, DATA COLLECTION, AND FUTURE MANAGEMENT OF LAKES 82

ADAPTIVE MANAGEMENT 83

OUTREACH AND EDUCATION 84

PARTNERSHIPS 85

LAKE TREATMENT METHODS 86

Mechanical Methods 86
Chemical Methods 91

FEASIBILITY OF FISH REMOVAL 94

Natural Treatment Methods 95

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE) 98

GENERAL CONCEPT 98

IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION 100

MINIMUM REQUIREMENTS 100

PROPOSED FISHERY MANAGEMENT PROGRAM 101

Proposed Management Framework 101
Proposed Stocking Program 101
Proposed Lake Treatments to Manage the Fishery 103
Proposed Mitigation 103
Proposed Monitoring Program 103
Cost of Implementation 103

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH) 106

GENERAL CONCEPT 106

IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION 108

MINIMUM REQUIREMENTS 108

PROPOSED FISHERY MANAGEMENT PROGRAM 109

Proposed Management Framework 109
Proposed Stocking Program 109

Proposed Lake Treatments to Manage the Fishery 111
Proposed Mitigation 111
Proposed Monitoring Program 111
Cost of Implementation 111

ALTERNATIVE D: 91 LAKES WOULD BE FISHLESS (ENVIRONMENTALLY PREFERRED ALTERNATIVE) 112

GENERAL CONCEPT 112

IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION 112

MINIMUM REQUIREMENTS 112

PROPOSED FISHERY MANAGEMENT PROGRAM 113

Proposed Management Framework 113
Proposed Stocking Program 114
Proposed Lake Treatments to Manage the Fishery 114
Proposed Mitigation 114
Proposed Monitoring Program 114
Cost of Implementation 115

HOW ALTERNATIVES MEET OBJECTIVES 115

ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION 118

CONSISTENCY WITH SECTIONS 101(B) AND 102(1) OF THE NATIONAL ENVIRONMENTAL POLICY ACT 119

ENVIRONMENTALLY PREFERRED ALTERNATIVE 122

AFFECTED ENVIRONMENT

INTRODUCTION 147

GENERAL PROJECT SETTING 147

Geographic Setting 147
Wilderness 148
Geologic Overview 149
Hydrology of the North Cascades Complex 150
Overview of Mountain Lakes 152
Mountain Lakes Water Quality 154
Origin of Mountain Biota 155

AQUATIC ORGANISMS 157

INTRODUCTION 157

INTRODUCTION TO LAKE ECOLOGY 157

How Aquatic Systems Work: Food Chains/Webs and Nutrient Cycling 157
How Organisms Are Organized: Ecosystems, Communities, Populations, and Metapopulations 160

PLANKTONIC ORGANISMS 161
  Phytoplankton 161
  Zooplankton 162

MACROINVERTEBRATES 163

AMPHIBIANS 165
  Long-Toed Salamander 165
  Northwestern Salamander 168

OTHER AMPHIBIANS 169
  Rough-Skinned Newt 170
  Pacific Tree Frog 170

FISH 171
  Native Fish Species 171
  Nonnative Fish in Mountain Lakes 175

WILDLIFE 179
MAMMALS 179
BIRDS 180
  Raptors 180
  Waterfowl 181
  Passerines 182

REPTILES AND AMPHIBIANS 182
SPECIAL STATUS SPECIES 183
FEDERALLY LISTED SPECIES 183
  California Wolverine 183
  Canada Lynx 184
  Gray Wolf 184
  Grizzly Bear 185
  Pacific Fisher 185
  Yuma Myotis 185
  Long-eared Bat 185
  American Peregrine Falcon 186
  Bald Eagle 186
  Harlequin Duck 186
  Marbled Murrelet 187
  Northern Spotted Owl 187
  Northern Goshawk 187
  Little Willow Flycatcher 187
  Olive-sided Flycatcher 188
  Cascades Frog 188
  Columbia Spotted Frog 189
  Northern Red-Legged Frog 189
  Tailed Frog 190

Western Toad 190
Bull Trout 191
Chinook Salmon 191
Coho Salmon 192
Westslope Cutthroat Trout 192

OTHER SPECIAL STATUS SPECIES 193

Animals 193
Black-backed Woodpecker 193
Common Loon 193
Golden Eagle 194
Lewis' Woodpecker 194
Merlin 194
Pileated Woodpecker 194
Vaux's Swift 194
Plants 195

VEGETATION 196

WEST SIDE 197

EAST SIDE 198

Deciduous Trees 198
Riparian Vegetation 198

CULTURAL RESOURCES 201

ARCHEOLOGICAL RESOURCES 201

Historic Structures and Districts 202
Ethnographic Resources 203
Cultural Landscapes 203

VISITOR USE AND EXPERIENCE 204

TYPES OF RECREATIONAL OPPORTUNITIES IN THE NORTH CASCADES COMPLEX 204

Hiking and Backcountry Camping 205
Climbing and Mountaineering 206
Stock Use and Horseback Riding 207
Fishing 207

SOCIAL VALUES 212

Attitudes Toward Wildlife 212
Social Values of Anglers and Angler User Groups 214
Social Values of Conservation Groups 215

WILDERNESS VALUES 217

HUMAN HEALTH 219

HUMAN HEALTH CONCERNS WITH POTENTIAL CONSUMPTION OF CHEMICALLY TREATED FISH 219

HUMAN HEALTH CONCERNS WITH POTENTIAL EXPOSURE TO METHYLMERCURY AND PERSISTENT ORGANIC POLLUTANTS THROUGH CONSUMPTION OF EXPOSED FISH 220

SOCIOECONOMIC RESOURCES 221

WHATCOM COUNTY 222

General Background, Land Use, and Population 222
Economy and Industry Trends 223
Tourism 224
Local Businesses 224

SKAGIT COUNTY 224

General Background, Land Use, and Population 224
Economy and Industry Trends 225
Tourism 225
Local Businesses 225

CHELAN COUNTY 225

General Background, Land Use, and Population 225
Economy and Industry Trends 226
Local Businesses 226

CURRENT ESTIMATED SPORT FISHING EXPENDITURES TO THE REGIONAL ECONOMY 227

CURRENT ESTIMATED SPORT FISHING EXPENDITURES TO THE LOCAL ECONOMY 228

NORTH CASCADES COMPLEX MANAGEMENT AND OPERATIONS 229

RESOURCES MANAGEMENT 229

EDUCATION AND INTERPRETATION 230

MAINTENANCE 230

CONCESSIONS 230

ENFORCEMENT 231

PARK FUNDING 231

CURRENT COST OF THE FISHERY MANAGEMENT PROGRAM 231

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION 235

SUMMARY OF LAWS AND POLICIES 235

GENERAL METHODOLOGY FOR ESTABLISHING IMPACT THRESHOLDS AND MEASURING EFFECTS BY RESOURCE 237

GENERAL ANALYSIS METHODS 237

ASSUMPTIONS ... 238

  Analysis Period ... 238
  Geographic Area Evaluated for Impacts ... 238
  Duration and Type of Impacts ... 239
  Future Trends ... 239

IMPACT THRESHOLDS ... 239

CUMULATIVE EFFECTS ANALYSIS METHOD ... 239

IMPAIRMENT ANALYSIS METHOD ... 241

AQUATIC ORGANISMS ... 243

GUIDING REGULATIONS AND POLICIES ... 243

METHODOLOGY AND ASSUMPTIONS ... 244

  Geographic Area Evaluated for Impacts ... 244
  Outcomes of the Management Actions ... 244
  Impact Criteria and Methodology ... 245
  Impact Threshold Definitions ... 246

IMPACTS OF THE ALTERNATIVES ON AQUATIC ORGANISMS ... 251

  Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) ... 251
  Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) ... 261
  Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) ... 267
  Alternative D: 91 Lakes Would Be Fishless ... 273

WILDLIFE ... 278

GUIDING REGULATIONS AND POLICIES ... 278

METHODOLOGY AND ASSUMPTIONS ... 279

  Geographic Area Evaluated for Impacts ... 279
  Outcomes of Management Actions ... 280
  Impact Criteria and Methodology ... 280
  Impact Threshold Definitions ... 280

IMPACTS OF THE ALTERNATIVES ON WILDLIFE ... 281

  Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) ... 282
  Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) ... 286
  Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) ... 289
  Alternative D: 91 Lakes Would Be Fishless ... 291

SPECIAL STATUS SPECIES ... 294

GUIDING REGULATIONS AND POLICIES 294

METHODOLOGY AND ASSUMPTIONS FOR SPECIAL STATUS WILDLIFE SPECIES 295

Geographic Area Evaluated for Impacts 295
Outcomes of the Management Actions 295
Impact Criteria and Methodology 296
Impact Threshold Definitions for Federally Listed Special Status Wildlife Species 296

IMPACTS OF THE ALTERNATIVES ON SPECIAL STATUS WILDLIFE SPECIES 298

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 298
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 309
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 315
Alternative D: 91 Lakes Would Be Fishless 320

METHODOLOGY AND ASSUMPTIONS FOR SPECIAL STATUS PLANT SPECIES 324

Vegetation Type 325
Presence or Absence of Fish 325
Accessibility of the Lakes to Anglers 325
Federally Listed Plants 326
Impact Threshold Definitions for State Listed Special Status Plant Species 327

IMPACTS OF THE ALTERNATIVES ON SPECIAL STATUS PLANT SPECIES 328

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 328
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 329
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 331
Alternative D: 91 Lakes Would Be Fishless 333

VEGETATION 335

GUIDING REGULATIONS AND POLICIES 335

METHODOLOGY AND ASSUMPTIONS FOR VEGETATION 335

Sources of Information 335
Assumptions 336
Definitions of Intensity Levels 337

IMPACTS OF THE ALTERNATIVES ON VEGETATION 339

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 339
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 342
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 344

Alternative D: 91 Lakes Would Be Fishless 348

CULTURAL RESOURCES 350

GUIDING REGULATIONS AND POLICIES 350

METHODOLOGY AND ASSUMPTIONS 351

Geographic Area Evaluated for Impacts 352
Definitions of Intensity Levels 352

IMPACTS COMMON TO ALL ALTERNATIVES 356

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 358
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 361
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 363
Alternative D: 91 Lakes Would Be Fishless 364

SECTION 106 SUMMARY 366

VISITOR USE AND EXPERIENCE 369

RECREATIONAL USE 369

GUIDING REGULATIONS AND POLICIES 369

METHODOLOGY AND ASSUMPTIONS 370

Geographic Area Evaluated for Impacts 370
Impact Threshold Definitions 370

IMPACTS OF THE ALTERNATIVES ON VISITOR RECREATIONAL USE 371

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 371
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 375
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 381
Alternative D: 91 Lakes Would Be Fishless 387

SOCIAL VALUES 391

GUIDING REGULATIONS AND POLICIES 391

METHODOLOGY AND ASSUMPTIONS 391

Geographic Area Evaluated for Impacts 391
Impact Threshold Definitions 392

IMPACTS OF THE ALTERNATIVES ON SOCIAL VALUES 392

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 392

Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 394
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 396
Alternative D: 91 Lakes Would Be Fishless 398

WILDERNESS VALUES 399

GUIDING REGULATIONS AND POLICIES 399

METHODOLOGY AND ASSUMPTIONS 399

Geographic Area Evaluated for Impacts 401
Impact Threshold Definitions 401

IMPACTS OF THE ALTERNATIVES ON WILDERNESS VALUES 402

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 402
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 405
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 409
Alternative D: 91 Lakes Would Be Fishless 413

HUMAN HEALTH 418

GUIDING REGULATIONS AND POLICIES 418

METHODOLOGY AND ASSUMPTIONS 418

Impact Threshold Definitions 418

IMPACTS OF THE ALTERNATIVES ON HUMAN HEALTH 419

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 419
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 420
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 422
Alternative D: 91 Lakes Would Be Fishless 423

SOCIOECONOMIC RESOURCES 425

GUIDING REGULATIONS AND POLICIES 425

METHODOLOGY AND ASSUMPTIONS 425

Geographic Area Evaluated for Impacts 425
Impact Threshold Definitions 425

IMPACTS OF THE ALTERNATIVES ON SOCIOECONOMIC RESOURCES 426

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 426

Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 428
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 430
Alternative D: 91 Lakes Would Be Fishless 432

MANAGEMENT AND OPERATIONS 434

GUIDING REGULATIONS AND POLICIES 434

METHODOLOGY AND ASSUMPTIONS 434

Geographic Area Evaluated for Impacts 435
Impact Threshold Definitions 435

IMPACTS OF THE MANAGEMENT ALTERNATIVES ON NORTH CASCADES COMPLEX MANAGEMENT AND OPERATIONS 436

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 436
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 437
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish) 442
Alternative D: 91 Lakes Would Be Fishless 445

SUSTAINABILITY AND LONG-TERM MANAGEMENT 447

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 447
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 447
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish) 448
Alternative D: 91 Lakes Would Be Fishless 448

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES 450

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 450
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 450
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish) 451
Alternative D: 91 Lakes Would Be Fishless 451

ADVERSE IMPACTS THAT COULD NOT BE AVOIDED 452

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish) 452
Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) 452
Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish) 452
Alternative D: 91 Lakes Would Be Fishless 453

CONSULTATION AND COORDINATION

HISTORY OF PUBLIC INVOLVEMENT 457

- THE SCOPING PROCESS 457
  - Internal Scoping 457
  - Public Scoping 458
- AGENCY CONSULTATION 459
  - USDA—Forest Service 459
  - Washington Department of Fish and Wildlife 460
  - U.S. Environmental Protection Agency 460
  - U.S. Fish and Wildlife Service 460
  - National Marine Fisheries Service 461
  - Native American Tribes 461
  - Washington State Historic Preservation Office 461
  - U.S. Geological Survey 462
- LIST OF PREPARERS AND CONSULTANTS 463
- LIST OF RECIPIENTS 465
  - Federal Departments and Agencies 465
  - Tribal Governments and Organizations 465
  - State of Washington Government 465
  - State of Washington Agencies 466
  - Washington Counties 466
  - State of Oregon 466
  - Organizations and Businesses 467
  - Media and Publications 467
  - Canada 467

TECHNICAL ADVISORY COMMITTEE CHARTER FOR THE MOUNTAIN LAKES FISHERY MANAGEMENT PLAN AND ENVIRONMENTAL IMPACT STATEMENT 468

- Functions 468
- Definitions 469

REFERENCES

REFERENCES 473

GLOSSARY, ACRONYMS, INDEX

GLOSSARY 491

ACRONYMS AND ABBREVIATIONS 500

INDEX 502

FIGURES

1: Vicinity Map ... 7

2: Mountain Lakes in the North Cascades Complex with a History of Fish Stocking ... 9

3: Management Model for Conserving Biological Integrity in Mountain Lakes ... 52

4: Status of 91 Lakes under Alternative A ... 73

5: Adaptive Management Process ... 85

6: Status of 91 Lakes under Alternative B ... 100

7: Status of 91 Lakes under Alternative C ... 108

8: Food Web for a Lake with Fish ... 159

9: 2003 Visitor Bsackcounty Overnight Use Activities ... 209

TABLES

1: Ecological Risk Factors for New Management Framework ... 55

2: Principles for Managing the Mountain Lakes Fishery to Conserve Biological Integrity ... 56

3: Decision Criteria for Management Actions ... 57

4: Description of Management Actions ... 65

5: Management Actions for Each of the 91 Lakes ... 66

6: Status of Fish Reproduction and Cycle, Stocking Density, and Species of Fish Stocked Comparison of Alternatives A, B, and C ... 68

7: Mechanical and Chemical Treatment Methods for Lakes with Reproducing Nonnative Fish ... 88

8: Factors that May Affect the Feasibility of Successfully Removing Reproducing Populations of Fish from Lakes ... 96

9: Natural Treatment Methods for Lakes with Nonreproducing Fish ... 97

10: Proposed Management Actions for Alternative B ... 99

11: Methods Used for Transporting Fish to Lakes Stocked under Alternatives A, B, and C ... 104

12: Proposed Management Actions for Alternative C ... 107

13: Proposed Management Actions for Alternative D ... 112

14: Alternatives Elements Summary ... 123

15: Summary of Environmental Consequences ... 129

16: Analyses of How Alternatives Meet Objectives ... 143

17: Range of Physical Attributes for Mountain Lakes with a History of Fish Stocking ... 153

18: Native Fish Species 172

19: Passerine Birds That Utilize Riparian Areas in the North Cascades Complex 182

20: Federally Listed Special Status Species Potentially Occurring in the North Cascades Complex 184

21: State of Washington Special Status Species with No Federal Status 193

22: Total Visitation to the North Cascades Complex, 1996 to 2002 204

23: Lakes Accessible by Horseback 207

24: Relative Popularity of Various Activities in the North Cascades Complex 210

25: Day-Use Angling Statistics 211

26: People's Perceptions of Animals in American Society 213

27: Whatcom County Demographics 223

28: Skagit County Demographics 224

29: Chelan County Demographics 226

30: Estimated Base Funding for the North Cascades Complex 232

31: Summary of Impact Thresholds – Aquatic Organisms 247

32: Outcomes of Applying Aquatic Organism Impact Thresholds 252

33: Sound Level Comparison Chart 283

34: Estimated Total Costs of the Fishery Management Program under Alternative B 438

35: Estimated Costs of Fish Removal for Management Actions under Alternative B 440

36: Estimated Costs of Fish Removal for Management Actions under Alternative C 443

Canada
Mt. Baker Wilderness
Mt. Shuksan
North C
Nationa
(north
Baker Lake
Skagit River
Marblemount
Sauk River
Suiattle River
Darrington
Boulder River Wilderness
0
5
10
20

Purpose of and Need for Action

Welcome

You are now in the "Purpose of and Need for Action" chapter. Here are the topics you can read about.

INTRODUCTION 3

PURPOSE OF AND NEED FOR ACTION 3

OBJECTIVES IN TAKING ACTION 5

PROJECT SITE LOCATION 6

BACKGROUND 10

SUMMARY OF EXISTING RESEARCH 15

SCOPING PROCESS AND PUBLIC PARTICIPATION 24

RELATED LAWS, POLICIES, PLANS, AND CONSTRAINTS 30

INTRODUCTION

This "Purpose of and Need for Action" chapter describes the reasons why the National Park Service (NPS) is taking action at this time to evaluate a range of alternatives and management actions for the mountain lakes fishery in the North Cascades National Park Service Complex (the North Cascades Complex). This *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS) presents three action alternatives for managing the mountain lakes fishery and assesses the impacts that could result from continuation of the current management framework (the no-action alternative) or implementation of any of the three action alternatives. Upon conclusion of the plan/EIS and decision-making process, one of the four alternatives would become the "Mountain Lakes Fishery Management Plan" and guide future actions for a period of 15 years.

The National Park Service (NPS) is the lead agency for development of this plan/EIS, and the Washington Department of Fish and Wildlife (WDFW) is a cooperating agency.

This plan/EIS is mostly programmatic in nature, which means it provides a framework for taking a range of management actions. Some actions would require additional, more site-specific analyses before they could be implemented. If additional analyses were required, environmental compliance, including an opportunity for public comment, would be completed.

PURPOSE OF AND NEED FOR ACTION

The "Purpose of the Plan" section of this chapter explains what the plan/EIS is intended to accomplish. The "Need for Action" section explains why action is necessary at this time. Brief summaries of both purpose and need are presented here, but a great deal more information is available in the "Background" section of this chapter.

PURPOSE OF THE PLAN

The purpose of this plan/EIS is to guide actions by the NPS and WDFW in order to

conserve native biological integrity

provide a spectrum of recreational opportunities and visitor experiences, including sport fishing resolve the long-standing debate and conflicts over fish stocking in the naturally fishless mountain lakes in North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area (which together make up the three NPS administrative units known as "North Cascades National Park Service Complex" or "the North Cascades Complex").

Biological integrity refers to "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region" (Karr and Dudley 1981).

NEED FOR ACTION

In most NPS units, natural resources (including lakes and fish) are managed in accordance with the *Organic Act of 1916* and *NPS Management Policies*, which allow sport fishing unless it is specifically prohibited (NPS 2001a, 4.4.3), but prohibit stocking in most NPS waters (see the section in this chapter titled "Planning Documents for North Cascades National Park Service Complex"). In the North Cascades Complex, fish have historically been managed by a combination of agencies and user groups. This is partly because the enabling legislation for the North Cascades Complex does not define the angling activities that would be allowed within its boundaries, and partly because the area has a history of fish management by the state of Washington and sport fishing groups. This history of fish management pre-dates the 1968 establishment of the North Cascades Complex by many years (see "History of Fish Management in North Cascades Mountain Lakes" in the "Background" section of this chapter for more information on the North Cascades Complex enabling legislation).

The lakes that are the focus of this plan/EIS are the 91 mountain lakes in the North Cascades Complex that were once naturally fishless, evolving over hundreds or thousands of years without any fish, but have had some history of fish stocking since the late 1800s.

Because of the differences in policies and missions between the WDFW and the NPS, the two agencies drafted a Memorandum of Understanding in 1985, followed by a Supplemental Agreement in 1988 (see appendix A) that established a mutually agreed to list of lakes in North Cascades National Park that the WDFW would stock with fish as part of its fish management program while further studies were being done. A long-term research study was then initiated to determine how continued stocking practices would affect native biota in mountain lakes.

Biota: The combined plant and animal life of a particular region.

Before this research could be completed, the NPS was challenged in court by the North Cascades Conservation Council on several issues relating to management of the North Cascades Complex. As a result, the NPS entered into a 1991 Consent Decree (see appendix A), wherein the NPS agreed to complete its research and then "conduct a NEPA [*National Environmental Policy Act*] review of the fish stocking of naturally fish-free lakes." The research was completed in July 2002 (Liss et al. 2002) by a team that included scientists from the U.S. Geological Survey (USGS) - Biological Resources Division and Oregon State University (OSU). The research was completed in three phases; full reports of the findings for each of these phases are available on the NPS website at http://www.nps.gov/noca/pphtml/relatedlinks.html. This plan/EIS was initiated shortly after the research was completed and is the document required in the 1991 Consent Decree.

OBJECTIVES IN TAKING ACTION

Objectives are more specific statements of purpose that support the goals an alternative must meet, to a large degree, for this plan/EIS to be considered a success. Meeting objectives to a large degree is part of what makes an alternative "reasonable." Objectives also support the purpose of this plan/EIS as stated in the "Purpose of the Plan" section above and help to resolve the need for action.

Objectives for fishery management are grounded in the North Cascades Complex's purpose, significance, and mission goals and are compatible with direction and guidance provided by both the *General Management Plan* (NPS 1988b) and *Strategic Plan* (NPS 2000a) for the North Cascades Complex (see the section titled "Planning Documents for North Cascades National Park Service Complex"). This plan/EIS must also be consistent with the following mission statement for the North Cascades Complex, which is derived from its enabling legislation (PL 90-544):

> As a unit of the National Park Service, the North Cascades National Park Service Complex is dedicated to conserving, unimpaired, the natural and cultural resources and values of North Cascades National Park, Ross Lake National Recreation Area and Lake Chelan National Recreation Area for the enjoyment, education, and inspiration of this and future generations. We also share responsibility for advancing a great variety of national and international programs designed to extend the benefits of natural and cultural resource conservation and outdoor recreation.

The following objectives were developed for this plan/EIS:

- Obtain support from interested parties and groups to implement a new management plan for mountain lakes within the North Cascades Complex should the governing agencies decide a new plan is needed.
- Advance the protection and rehabilitation of native biological integrity by maintaining native species abundance, viability, and sustainability.
- Provide a spectrum of recreational opportunities, including sport fishing, while minimizing impacts to the biological integrity of natural mountain lakes.
- Apply science and research in decision-making at multiple spatial scales that include landscape, watershed, lake cluster, and individual lakes.
- Provide to the public and interested parties full and open access to available information.

PROJECT SITE LOCATION

State Route 20 follows the Skagit River and Skagit River Hydroelectric Project for much of its way through the North Cascades Complex.

The 684,000-acre North Cascades Complex is located in the northwest part of Washington State, with its northern boundary forming the international border with Canada (see "Figure 1: Vicinity Map"). The North Cascades Complex is made up of three NPS administrative units: North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area. The North Cascades Complex lies within the Washington counties of Whatcom, Skagit, and Chelan. The only drivable access is by way of scenic Washington State Route 20, commonly referred to as the North Cascades Highway, which bisects the North Cascades Complex as it makes its way through Ross Lake National Recreation Area, the most accessible part of the North Cascades Complex. State Route 20 intersects with Interstate 5 approximately 70 miles to the west and with State Route 97 approximately 85 miles to the east. Three reservoirs within the Ross Lake National Recreation Area (Ross Lake, Diablo Lake, and Gorge Lake) serve as water gateways to the remote areas within the North Cascades Complex.

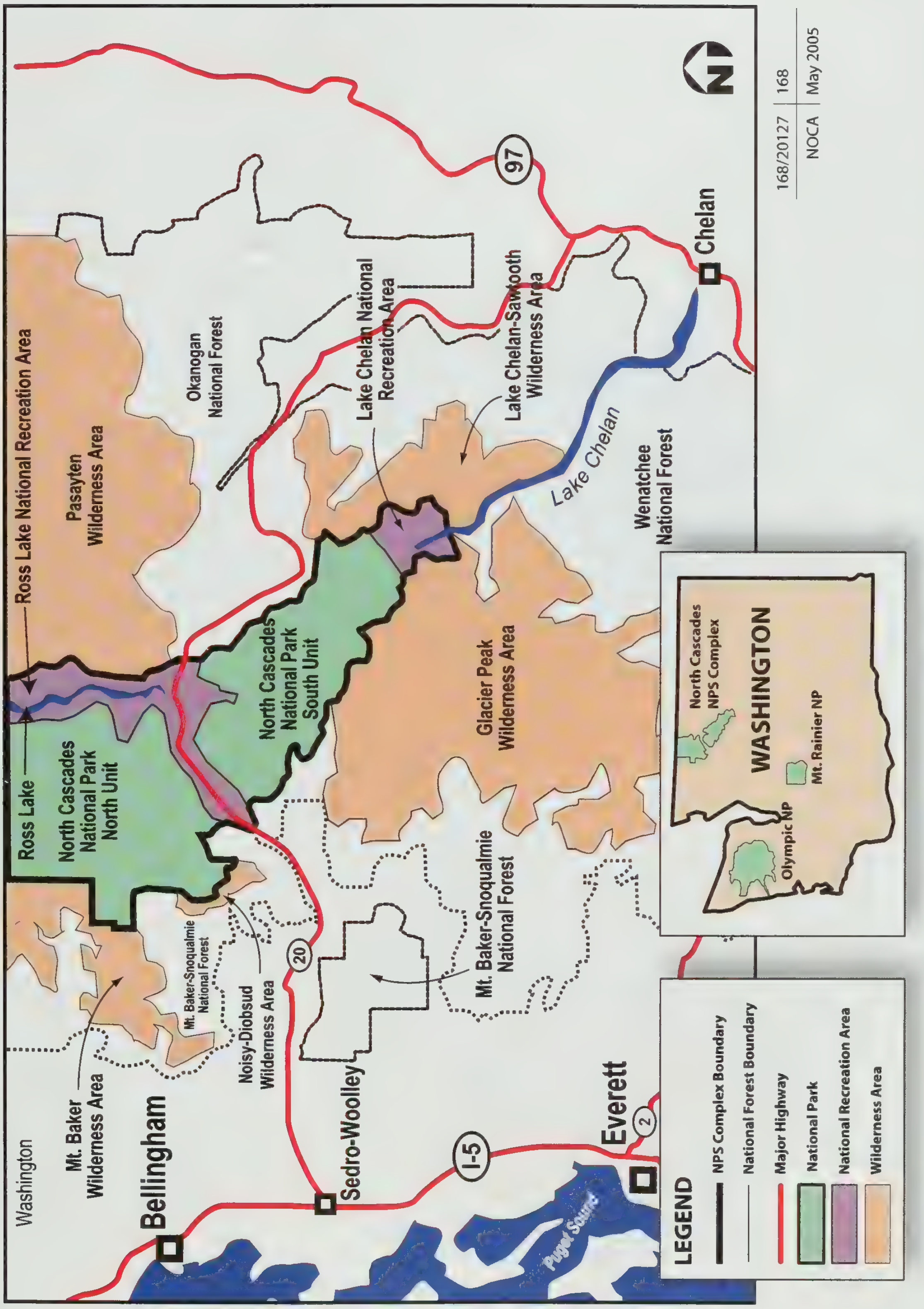
As shown on figure 1, many other public lands surround the North Cascades Complex. The Okanogan National Forest to the east includes two wilderness areas: the Pasayten Wilderness Area that runs along the eastern boundary of Ross Lake National Recreation Area and the Lake Chelan-Sawtooth Wilderness Area that is adjacent to the eastern boundary of the Lake Chelan National Recreation Area.

The Glacier Peak Wilderness Area adjoins most of the southern boundary of Lake Chelan National Recreation Area and the South Unit of North Cascades National Park. The Glacier Peak Wilderness Area encompasses parts of the Wenatchee National Forest and Mount Baker-Snoqualmie National Forest.

The Mount Baker-Snoqualmie National Forest extends along the western boundary of the North Cascades Complex and includes two other wilderness areas: the Noisy-Diobsud Wilderness (situated between North Cascades National Park and Baker Lake) and the Mount Baker Wilderness farther north. These two wilderness areas are adjacent to parts of the North Unit of North Cascades National Park. Fish stocking has occurred in the lakes within these National Forest System boundaries since the late 1800s.

The geographic study area for this plan/EIS includes all three administrative units of the North Cascades Complex. However, the focus of this document is the 91 naturally formed mountain lakes in the North Cascades Complex that have a history of fish presence. As noted below in the section titled "History of Fish Management in North Cascades Mountain Lakes," the North Cascades Complex comprises a total of 245 mountain lakes. At least 154 of these lakes have always been, and would continue to be, fishless regardless of the alternative selected. Because no changes in this policy are anticipated for any of the 154 lakes, and

FIGURE 1: VICINITY MAP


British Columbia
Washington
Ross Lake National Recreation Area
Pasayten Wilderness Area
Okanogan National Forest
Ross Lake
North Cascades National Park North Unit
North Cascades National Park South Unit
Lake Chelan National Recreation Area
Lake Chelan-Sawtooth Wilderness Area
Lake Chelan
Chelan
97
Wenatchee National Forest
Glacier Peak Wilderness Area
Mt. Baker Wilderness Area
Mt. Baker-Snoqualmie National Forest
Noisy-Diobsud Wilderness Area
Mt. Baker-Snoqualmie National Forest
20
Bellingham
Sedro-Woolley
I-5
Everett
2
Puget Sound
N
North Cascades NPS Complex
WASHINGTON
Olympic NP
Mt. Rainier NP
LEGEND
NPS Complex Boundary
National Forest Boundary
Major Highway
National Park
National Recreation Area
Wilderness Area

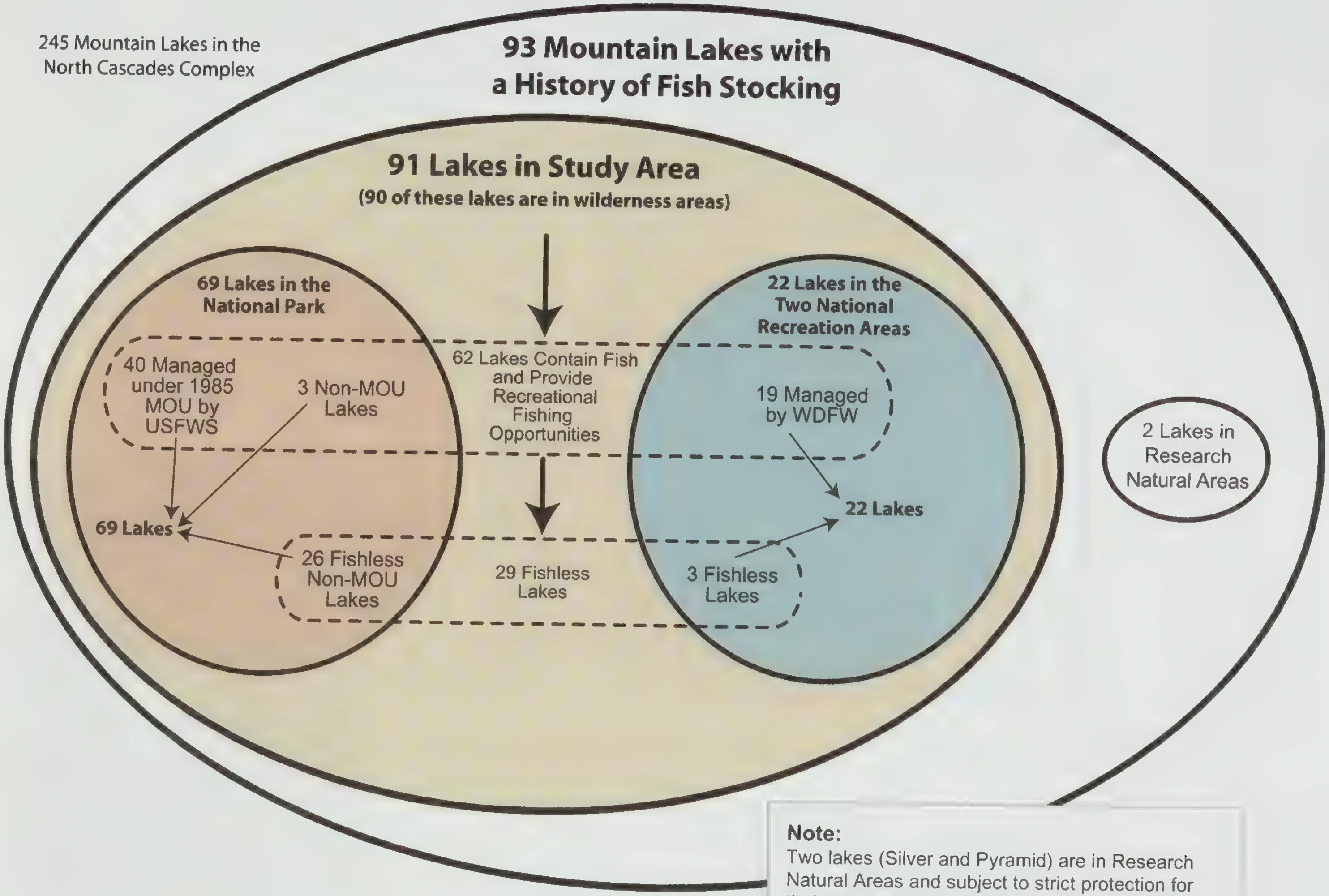
168/20127 | 168
NOCA | May 2005

because they have never been part of the managed fishery at the North Cascades Complex, they are not addressed further in this document. Reservoirs, streams, and their associated beaver ponds are also not included in this plan/EIS.

The 91 lakes include all naturally fishless mountain lakes that have documented stocking records, as well as those where no stocking records exist but where observations or harvest of fish have been documented. Documented stocking records are taken from the database maintained by Trail Blazers, Inc., a volunteer group founded in 1933 with a focus on fish stocking and surveying activities (see the section in this chapter titled “User Groups’ Involvement in North Cascades Complex Fishery Management”). The 91 lakes analyzed in this plan/EIS include those stocked with fish that are now reproducing and self-sustaining, lakes that are stocked repeatedly because they contain nonreproducing fish, and lakes that have been stocked in the past, but are now fishless.

“Map 1” (contained in the envelope that accompanied this plan/EIS) shows the locations of the 91 lakes: 69 lakes are in the national park, 7 are in Ross Lake National Recreation Area, and 15 are in Lake Chelan National Recreation Area. Of the 69 lakes inside the national park boundary, the WDFW manages 40 under the terms of the 1985 Memorandum of Understanding with the NPS. The WDFW also manages 19 lakes in the national recreation areas—3 of those lakes are fishless and not actively managed. The remaining 29 lakes are not actively managed by either the WDFW or NPS. Of the 91 lakes, 62 currently have fish, and 29 are fishless (see figure 2).

FIGURE 2: MOUNTAIN LAKES IN THE NORTH CASCADES COMPLEX WITH A HISTORY OF FISH STOCKING


245 Mountain Lakes in the North Cascades Complex
93 Mountain Lakes with a History of Fish Stocking
91 Lakes in Study Area
(90 of these lakes are in wilderness areas)
69 Lakes in the National Park
40 Managed under 1985 MOU by USFWS
3 Non-MOU Lakes
69 Lakes
26 Fishless Non-MOU Lakes
62 Lakes Contain Fish and Provide Recreational Fishing Opportunities
29 Fishless Lakes
22 Lakes in the Two National Recreation Areas
19 Managed by WDFW
22 Lakes
3 Fishless Lakes
2 Lakes in Research Natural Areas

Note:
Two lakes (Silver and Pyramid) are in Research Natural Areas and subject to strict protection for their scientific values. Both lakes have a history of fish presence but are currently fishless. Silver Lake was last stocked in 1961, and 1980 surveys showed no fish remained. Pyramid Lake was last stocked in 1968, and 1999 surveys showed no fish were in the lake.

BACKGROUND

This section is divided into two parts—the administrative background, including the history of fishery management practices in the study area, and a summary of the scientific background, which includes major findings of the research study described above in the "Need for Action" section.

ADMINISTRATIVE BACKGROUND

From the time the United States established title to the Oregon Territory in 1846, until the 1890s, the area encompassing the North Cascades Complex was administered as part of the public domain. During the 1890s, Congress established two large forest reserves that were administered by the General Land Office of the Department of the Interior. Out of these reserves, Congress created Mount Rainier National Park in 1899, and the rest of the land was transferred to the administrative jurisdiction of the U.S. Forest Service, which established five national forests in the area. Over the years, in recognition of the outdoor recreation values of the area, the Mount Baker Recreation Area was established, and almost a million acres of wild and roadless primitive areas were set aside. In 1963 President Kennedy ordered a review of the North Cascades region to determine the highest and best use of the area. The resulting report included a recommendation to establish a national park, which Congress acted on, thus creating the North Cascades Complex in 1968 (Louter 2003).

HISTORY OF FISH MANAGEMENT IN NORTH CASCADES MOUNTAIN LAKES

The North Cascades Complex contains 561 natural water bodies that include lakes, tarns, and ponds. Approximately 245 (44%) of these water bodies are considered mountain lakes because of their elevation, size, and depth. As noted in the "Need for Action" section above, the focus of this plan/EIS is on the 91 mountain lakes that were stocked in the past or are currently stocked but that were once naturally fishless due to the lack of inlets or outlets to streams or the presence of impassable physical barriers (such as cascades) to upstream fish migration.

Fish stocking Thunder Lake in the early years.

Settlers began stocking North Cascades lakes in the late 1800s with exotic (nonnative) fish. By the 20th century, stocking was a routine management practice of the U.S. Forest Service and various counties.

In 1933 the Washington Department of Game (currently the WDFW) assumed responsibility for stocking mountain lakes throughout the state in order to establish and maintain a recreational fishery. The department's involvement grew largely out of the need to prevent haphazard stocking by individuals without expertise in biology. With particular emphasis on systematic assessment of fish species and stocking rates, the department conducted the first high-lakes fisheries research. Since its creation, many agencies and groups have collaborated to assist in managing the natural resources in the North Cascades Complex. These include state and federal agencies, such as the WDFW, and sport fishing groups such as the Washington State Hi-Lakers and Trail Blazers, Inc. (see the section titled "User Groups' Involvement in North Cascades Complex Fishery Management").

According to Louter (2003):

> The 1960s marked an important turning point for resource management based upon ecological principles in national parks. The Park Service shifted its management direction in response to critics and scientific studies that claimed that the agency had too long managed parks for their scenic facade. Without scientific research to inform management decisions, the Park Service had manipulated nature's paradise—such as killing predators—often with unintended and long-term consequences to the natural systems of parks. The most influential critique of the agency's management of nature was the so-called Leopold Report of 1963. Prepared by the Advisory Board on Wildlife Management in National Parks, and chaired by A. Starker Leopold, son of ecologist Aldo Leopold, the report recommended maintaining, and when possible restoring, "natural park environments to the greatest extent possible." On May 2, 1963, Secretary of the Interior Stewart L. Udall approved the board's recommendations and directed that they become part of Park Service policy.
>
> Although Park Service policies and legislation would further strengthen the agency's commitment to environmental protection, the Leopold Report was its first expression and thus formed the cornerstone of the Park Service's management of North Cascades. Beginning in the late 1960s and early 1970s, the agency focused on ecological research and restoration as the primary elements of the park's resource management program. One of its major efforts was the protection and restoration of the park's fragile alpine ecosystems, but it also turned its attention to the question of fish stocking in the park's high alpine lakes.

Consistent with the recommendations of the Leopold Report, Sequoia Kings Canyon and Yosemite National Parks began phasing out trout stocking in the late 1960s. In 1972 the NPS released its policy that stated, "No artificial stocking of fish species exotic to a park will occur, artificial stocking of fish or eggs may only be employed to reestablish a native species. Naturally barren waters will not be stocked with either native or exotic fish species" (Louter 2003). Limited stocking was continued in these park units until 1991, when an agreement was negotiated with the state to terminate all fish stocking in these parks (Knapp 1996).

When the North Cascades Complex was established in 1968, its enabling legislation did not define the fishing activities that would be allowed within its

boundaries. This has left the *North Cascades Act* open to interpretation. According to Louter (2003),

> The WDFW has noted that the legislation did more than give it the authority to issue hunting and fishing licenses. In earlier versions of the Act, Lake Chelan had been included in the national park. But lobbying from hunters, who did not want to see some prime areas closed off to them, convinced Congress to place the region within a recreation area. Congress also responded to concerns about the state's fishery management program for Lake Chelan with the creation of the recreation area, for it specifically accommodated the fish hatchery programs in the Stehekin River drainage at the headwaters of the lake. The department further believed that because the Act granted it licensing authority for hunting and fishing, it recognized and thus approved of its past management practices in the new park. In short, it authorized the state game department [currently WDFW] to carry on with its fish stocking program (1986 memorandum [see appendix A]).

In addition to the influence of the Leopold report, *NPS Management Policies* (NPS 2001a) prohibit stocking in units of the NPS in order to protect native ecosystems.

To resolve differences in policy and to foster a spirit of cooperation, the NPS and WDFW negotiated a series of agreements beginning in 1979 that allowed stocking to continue in selected lakes in the North Cascades Complex. Currently, the management of mountain lakes is performed under a temporary extension of the 1985 Memorandum of Understanding and 1988 Supplemental Agreement between the two agencies. Both of these documents (see appendix A for copies) were written "to continue cooperative efforts in management of protection and enhancement of the fisheries and wildlife resources of mutual concern." The Memorandum of Understanding provided "Statements of Work" (or directives) for both the NPS and the WDFW. The three main management directives from the Memorandum of Understanding that, in part, pertain to fish management are

> To consult with the Department [WDFW] prior to initiating research projects or implementing plans, programs, or regulations affecting fish and wildlife species distribution, numbers, or public use of fish and wildlife found within areas administered by the Service [NPS].
>
> To practice those forms of management which will benefit fish and wildlife, and their habitats, and to maintain or restore their natural and historic distribution and abundance, consistent with the respective Service [NPS] policies and park objectives.
>
> To permit the harvest of fish and wildlife in accordance with applicable state laws and regulations of the Department [WDFW] in those areas under the jurisdiction of the Service [NPS], which are open to hunting and/or fishing. It is recognized that some park regulations may vary for management purposes.

To be able to continue stocking in light of NPS policies generally prohibiting it, a memorandum from the NPS Director was issued in 1986 (hereinafter referred to as the "policy waiver"). The policy waiver states "fishing is an acceptable recreational activity in the park, provided it is done consistent with *NPS Management Policies* and with provisions of the *General Management Plan*, and other approved plans" (see appendix A). The policy waiver only allowed stocking with fish species that are native to the national park or native to the ecological region. Any species native only to the ecological region were to be restricted so that the species did not become established (that is, reproducing populations) in natural zone waters. The waiver acknowledged long-standing fish-stocking practices and allowed for continued stocking in selected lakes while ecological research was conducted to determine the impacts of fish stocking. The policy waiver allowed fish stocking to continue in 17 lakes and self-sustaining (reproducing) fish populations to continue in 23 lakes in the park.

The 1988 Supplemental Agreement (also known as the Fisheries Management Agreement) formalized these practices in the 40 lakes inside the park for 12 years while planned research on the effects of fish management activities could be completed and assessed. Any additions or deletions to the list of lakes in the park would be made only by mutual agreement, and the two agencies would consult on the number and species of fish, specific lakes, and the schedule for the lakes to be stocked. The agreement added the caveat that research results would be considered in future decisions. A long-term research study was initiated by Oregon State University soon after the 1988 Supplemental Agreement was finalized. The Supplemental Agreement between the NPS and WDFW that permits fish stocking in the national park was reaffirmed in February 2000 and again in July of 2002. The agreement expired in December 2004. Any future agreements between the NPS and WDFW concerning mountain lakes fishery management, including fish stocking in the national park, would depend on the outcome of this plan/EIS process.

The lakes in the two national recreation areas were not part of the 1988 Supplemental Agreement, and the WDFW continued to manage the fisheries in the Ross Lake and Lake Chelan National Recreation Areas according to historical practices. The management program currently in place is further described as "alternative A" in the "Alternatives" chapter. In 1991 the North Cascades Conservation Council challenged the NPS on a number of issues that brought about a Consent Decree between the two parties. In part, the Consent Decree ordered the NPS to "conduct a NEPA [*National Environmental Policy Act*] review of the fish stocking of naturally fish-free lakes within [the park] upon completion of ongoing research." As noted above, this plan/EIS has been prepared, in part, as a result of the Consent Decree. This plan/EIS incorporates the results of the OSU study and other research into the impact analysis of the alternatives for management of the mountain lakes fishery as identified in the "Alternatives" chapter.

Despite the ongoing commitment to provide for a cooperative arrangement with the WDFW, there is still a question of what Congress intended when it established the North Cascades Complex in 1968 (NPS 1968). Throughout the years leading up to 1968, the WDFW and Trail Blazers had stocked 75 lakes in the newly designated North Cascades Complex. During public hearings on the bill to establish the North Cascades Complex, NPS Director George Hartzog made statements as to whether the NPS intended to continue stocking lakes in the North Cascades Complex. In May 1967 he stated that within the park the NPS would not participate in a 'put and take' program, and would not concur with stocking lakes that historically did not have fish. Then, in July 1968, Director Hartzog stated, "[w]e have an active fish-[stocking] program in every single major park . . . [n]ow, if the stream already has its limit of fish comparable with its food-carrying capacity, then obviously, we do not engage in a put-and-take fishing program. But, we [stock] fish in practically every area that I can think of off the top of my head now, including all of our major parks." Proponents of stocking believed they were promised that stocking would continue after the park was established (Trail Blazers and Hi-Lakers, S. McKean, public scoping comment, 2003, see the "Public Comment Summary Report" for comments received during the public scoping process: http://www.nps.gov/noca/highlakes.htm).

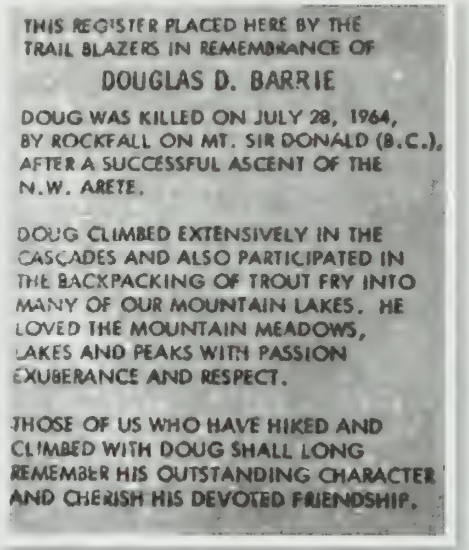
Proponents of stocking also believed that the circumstances surrounding the creation of Lake Chelan National Recreation Area reflected the need to accommodate sport fishing and hunting. Although there is no specific language in the 1968 enabling legislation that permits stocking, proponents claim that continuation of stocking is implied through a reference to cooperative management between the NPS and the state of Washington (Louter 2003: http://nps.gov/noca/whitepaper.htm). While the current *NPS Management Policies* and practices prohibit stocking in areas designated as national parks, it allows stocking in areas designated as national recreation areas that have been historically stocked, provided the impacts of such stocking are acceptable (NPS 2001a, 4.4.3). The NPS recognizes that stocking is a part of the management legacy it inherited from the U.S. Forest Service (Louter 2003). Given these questions, the NPS seeks, as part of this planning effort, clarification from Congress on the NPS authority to enter into future agreements regarding stocking fish in the North Cascades Complex. Depending on the congressional response, the NPS may not be able to implement some alternatives (see the section in the "Alternatives" chapter titled "Implementing the Fishery Management Plan through Congressional Action").

Members of the Trail Blazers stocking Doug's Tarn.

USER GROUPS' INVOLVEMENT IN NORTH CASCADES COMPLEX FISHERY MANAGEMENT

The Washington State Hi-Lakers are a diverse group of anglers "dedicated to the preservation of the high-lake environment and to the maintenance of a quality fishery that is compatible with the high lake environment" (http://groups.yahoo.com/group/hilakers/). The Hi-Lakers work with the WDFW to survey lake conditions and provide data to the department's biologists. The department's biologists, in turn, use this data to assist in managing the lakes of the North Cascades Complex. The Hi-Lakers' fishing reports have also served as a data source for some of the information used to manage the mountain lakes fishery program in the North Cascades Complex.

Founded in 1933, Trail Blazers, Inc. is a 55-member volunteer group that also works with the WDFW to assist with managing lake fisheries across the state of Washington. The group's focus is on fish stocking and surveying activities. Over the years, the Trail Blazers have been involved in carrying and stocking fry, collecting data, building a lake and stream database, and providing funds for fish-related equipment. The Trail Blazers have stocking and survey records dating as far back as 1934. The Trail Blazers' database has also been useful in compiling much of the stocking and user information used for this plan/EIS. The database provides information on lake and stream identity, water chemistry, water biology, fish observations, fish stocking, and recreational use.



THIS REGISTER PLACED HERE BY THE
TRAIL BLAZERS IN REMEMBRANCE OF

DOUGLAS D. BARRIE

DOUG WAS KILLED ON JULY 28, 1964,
BY ROCKFALL ON MT. SIR DONALD (B.C.),
AFTER A SUCCESSFUL ASCENT OF THE
N.W. ARETE.

DOUG CLIMBED EXTENSIVELY IN THE
CASCADES AND ALSO PARTICIPATED IN
THE BACKPACKING OF TROUT FRY INTO
MANY OF OUR MOUNTAIN LAKES. HE
LOVED THE MOUNTAIN MEADOWS,
LAKES AND PEAKS WITH PASSION
EXUBERANCE AND RESPECT.

THOSE OF US WHO HAVE HIKED AND
CLIMBED WITH DOUG SHALL LONG
REMEMBER HIS OUTSTANDING CHARACTER
AND CHERISH HIS DEVOTED FRIENDSHIP.

A memorial to a dedicated Trail Blazer.

Another notable group that has influenced the fishery management program is the North Cascades Conservation Council. Formed in 1957, the council's mission is to "to protect and preserve the North Cascades' scenic, scientific, recreational, educational, and wilderness values" (NCCC 2004). The group seeks to keep "government officials, environmental organizations, and the general public informed about issues affecting the Greater North Cascades Ecosystem." The 1991 Consent Decree (described in the "Need for Action" section above) was the result of a 1989 lawsuit brought on behalf of the council in the U.S. District Court, Western District of Washington.

Other important milestone information related to fish stocking in the North Cascades Complex is contained in appendix B.

SUMMARY OF EXISTING RESEARCH

After the 1988 Supplemental Agreement was finalized, the NPS initiated a long-term research effort through Oregon State University to evaluate the effects of fish stocking on native biota in mountain lakes. Later efforts included research by the USGS-Biological Resources Division. A scientific peer review panel of subject matter experts was established to evaluate the OSU research results and to ensure objectivity and scientific merit. Representatives from the NPS and WDFW were invited to attend all review panel meetings. The phase I research report was completed in March 1995 (Liss et al. 1995), the phase II report was completed in April 1999 (Liss et al. 1999), and the third and final phase was completed in July 2002 (Liss et al. 2002). The full text for the three reports is available at
http://www.nps.gov/noca/pphtml/relatedlinks.html.

In addition to the results of these contracted studies, this section summarizes relevant research completed in the region. The way this research was used in formulating the alternative is described in the "Alternatives" chapter in the section titled "Application of Research."

Taxa or taxon: A category of organisms. Any of the groups to which organisms are assigned according to the principles of taxonomy, including species, genus, family, order, class, and phylum.

The OSU studies, and later the USGS studies, were aimed at gaining an understanding of the aquatic ecosystems in mountain lakes in the North Cascades Complex and determining whether, or to what extent, different fishery management practices had altered those ecosystems. First, the researchers studied the lakes—the shape and depth, temperature, surrounding vegetation, location, geology, and other features. They then examined the aquatic life in each lake, including sensitive taxa at each of the "trophic levels" of the aquatic food web. Phytoplankton are very small, usually single-celled floating plants that make up one part of the base of the aquatic food web. Zooplankton are microscopic floating animals that include copepods and cladocerans. Certain types of copepods were found to be particularly affected by fishery management practices and so were researched in more depth. Macroinvertebrates (such as worms, snails, and amphipods) are larger animals than zooplankton in a lake ecosystem and live on the lake bottom. The top predator in fishless lakes in the North Cascades Complex is usually an amphibian and most commonly the long-toed salamander. These vertebrate animals feed on macroinvertebrates and larger zooplankton which, in turn, feed on phytoplankton. (A detailed and informative discussion about how aquatic systems work is presented in "Introduction to Lake Ecology" under the "Aquatic Resources" section in the "Affected Environment" chapter.) Fish can also be top predators, and when they are introduced to a naturally fishless lake, they eat some of the same foods as salamanders, including macroinvertebrates and larger zooplankton. Fish also consume larval salamanders themselves. Long-toed salamanders occur over a large area of the North Cascades Complex, and they are particularly sensitive to changes in fishery management practices; therefore, to understand impacts to the top predator in lake food webs, researchers focused their efforts on the long-toed salamander.

Trophic Levels: The various positions of a food web that are occupied by specific organisms, from the lowest-level organisms, such as phytoplankton, to top predators, such as amphibians or fish.

Lake Characteristics. The phase I (Liss et al. 1995) and phase II (Liss et al. 1999) reports examined different characteristics of mountain lakes. The researchers found that some characteristics were different depending on whether the lake was on the east or west side of the hydrologic divide (Cascade Crest) of the North Cascades Mountains. On the west-facing side, skies were generally cloudier, and the climate was more maritime, with temperatures less extreme in both winter and summer than on the east side of the divide. Conditions on the east side of the crest were consistent with a semiarid continental climate—summers were sunnier and hotter and winters colder than on the west side. A given vegetative type occurred at higher elevations on the east side than the west side; however, the date at which a given lake would normally "ice-out" or thaw in the spring or summer was still earlier for east-side lakes in a particular type of vegetation than those on the west side. Regardless of whether the lake was on the east or west side of the crest, both the date of ice-out and water temperature were related to the elevation of the lake, ice-out occurred later, and the average temperature was lower at lakes with higher elevations.

The water quality of lakes was found to be associated with elevation as well. As elevation decreased, pH, alkalinity, conductivity, and concentrations of total phosphorus and total Kjeldahl nitrogen (TKN) generally increased (there were some exceptions). East-side high-elevation lakes had significantly higher pH and alkalinity levels and concentrations of TKN and phosphorus than west-side high-elevation lakes. In addition to the climatic differences described above, the authors indicated these changes were associated with increased biomass of terrestrial vegetation, soil depth and maturity, dissolved substances, and nutrient availability (Larson and Lomnicky et al. 1999). The majority of lakes studied in the North Cascades Complex had very low nutrient levels.

Total Kjeldahl Nitrogen (TKN): A measure of ammonia plus all organically derived nitrogen, and in combination with phosphorus concentrations, is a good indicator of a lake's productivity.

In terms of possible impacts to lake characteristics from fishery management practices, the literature indicates that removal of fish can result in increased water clarity, higher dissolved oxygen concentrations, reduced phosphorus cycling, and decreased ammonia concentrations (Hanson 1990; Sondergaard et al. 1990; Schindler et al. 2001). In contrast to the low-nutrient and relatively undisturbed conditions in mountain lakes analyzed in this plan/EIS, these prior studies were conducted in highly disturbed, nutrient-rich lakes containing high densities of fish. For example, researchers in the Sierra Nevada have demonstrated through modeling and paleolimnological (study of the organic and chemical history of lakes through analysis of bottom sediments) analyses that introduced fish in oligotrophic (nutrient poor) mountain lakes can nearly double the rate of phosphorus regeneration and exploit benthic (lake bottom) sources of phosphorus that would normally not be available to pelagic (open water) communities in the absence of fish. The increased availability of nutrients (such as phosphorus) made possible by stocked fish can stimulate primary productivity and fundamentally alter nutrient cycling (Schindler et al. 2001). The USGS research at the North Cascades Complex did not study the effect of fish on water quality or nutrient cycling. It instead focused on abiotic factors, such as characteristics of the drainage basin and elevation and their effects on water quality (Liss et al. 1995). It is unknown, but considered unlikely, that similar water-quality changes would be associated with the presence of fish or fish removal (Drake and Naiman 2000).

Phytoplankton. The concentration of phytoplankton in study area lakes generally increased with increasing concentrations of dissolved solids, TKN, total phosphorus (there were exceptions to this), and temperature. The density of phytoplankton generally increased as lake elevation decreased. Species richness was positively correlated with the concentration of total phosphorus that, with the exception of glacially turbid lakes, increased with decreasing elevation. The form in which nitrogen was available to phytoplankton (for example, as either dissolved or TKN) in a lake was an important variable in identifying species differences of the phytoplankton assemblages among lakes.

Abiotic Factors: The nonliving physical and chemical aspects of an organism's environment. Abiotic refers to such factors as light, temperature, elevation, and topography.

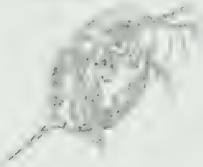
Phytoplankton surveys performed in mountain lakes in Mount Rainier National Park showed that, for the most part, the species of phytoplankton in individual lakes remained consistent from year to year (Larson and McIntire et al. 1999). Drake and Naiman (2000) compared fossil remains of one type of phytoplankton (diatom) in historically fishless lakes, lakes with stocked fish, and lakes where stocked fish were removed in Mount Rainier and found that in unstocked lakes, the array (variety and abundance of species) of diatoms had not changed significantly in the last 315 years. Changes had occurred in diatom arrays in lakes where fish were introduced and are still present today. For those lakes where the stocked fish had been removed, diatom arrays did not appear to have returned to the arrays similar to those found in fishless lakes. Changes in species arrays, resembling those observed in the Drake and Naiman (2000) study, have also been observed in other studies, such as Douglas et al. (1994). Several studies have shown that removal of fish from lakes can result in decreased total numbers of phytoplankton (Hanson 1990; Sondergaard et al. 1990). It is difficult to quantify fish impact on nutrient cycling, especially in oligotrophic lentic (still or slow-moving water) systems, and the magnitude and variation of impact has not been fully explored (Schindler et al. 2001).

fish

amphibians

macroinvertebrates

zooplankton



phytoplankton

Zooplankton. Zooplankton include a wide variety of organisms such as rotifers and crustacean zooplankton. Rotifers are widely distributed in the lakes of the North Cascades Complex and may be the dominant zooplankton under certain conditions; however, they are small and seldom a significant portion of the diet of stocked fish in mountain lakes (Dawidowicz and Gliwicz 1983). The crustacean zooplankton community includes cladocerans and copepods. In the studies performed by Oregon State University and the U.S. Geological Survey (Liss et al. 2002), analysis of stomach contents indicated that salamanders primarily consumed cladoceran zooplankton (*Daphnia rosea*, in particular), and fish preferred large copepods of the genus *Diaptomus*. These are referred to in the reports and in the remainder of this plan/EIS as “diaptomid” copepods. Both salamanders and fish also ate other species of zooplankton and benthic macroinvertebrates.

Researchers found that crustacean zooplankton vary depending on lake characteristics, soils, vegetation, and elevation. The high-elevation west-side lakes, which on average had lower water temperatures, alkalinity, and nutrients, were dominated by *Diaptomus kenai (D. kenai*). Smaller, shallower lakes on the east side were populated primarily with the smaller copepod, *D. tyrrelli,* which was also found only in lakes with higher nutrient levels. *D. kenai* is widespread in lakes in the study area and is apparently able to tolerate a wide range of abiotic conditions. However, in lakes where the average water temperature was below 50ºF–54ºF (Fahrenheit), these and all other larger copepods were virtually absent regardless of whether fish were present (Liss et al. 2002). Although the smaller *D. tyrrelli* rarely occurs together with large copepods (such as *D. kenai*) in east-side lakes, they do occur together in lower-elevation west-side lakes. In these cases, the density of *D. tyrrelli* is depressed compared to lakes where it occurs without *D. kenai*, suggesting predation by the larger copepod on *D. tyrrelli* (Liss et al. 1995).

In lakes where abiotic conditions were favorable for large copepods (generally where temperatures were warmer than 54ºF), densities of copepods were much lower where the lake also supported reproducing fish populations. Reproducing fish populations are believed to exert a particularly great predation pressure because densities of reproducing fish can be high. In addition, the population produces a range of age and size classes, making a wider range of prey vulnerable. Researchers found no significant differences in the density of large copepods in lakes with low fish densities (such as in many stocked lakes) and in fishless lakes (Liss et al. 1998). Where both deep lakes and shallow lakes had reproducing fish populations, deep lakes (deeper than 32 feet) supported higher densities of large copepods than shallow lakes. The researchers theorized that this is because the zooplankton are able to migrate to deep water during the day and avoid predation. Researchers also found *D. tyrrelli* to be abundant in shallow lakes with high fish densities where larger diaptomids were either absent or low in abundance. This is an example of an indirect effect of stocking or of

reproducing fish populations (for instance, if the larger copepod is removed through predation by fish, the smaller species is able to increase its density). The OSU/USGS team came to several conclusions:

> Introduced fish can reduce or eliminate large, more visible diaptomid copepods from lakes if fish abundance is excessive.
>
> Impacts on large copepods vary with fish density, with the greatest effects occurring at high fish densities.
>
> Impacts on large copepods from fish introductions are greater in shallow lakes.
>
> A significant negative relationship between large diaptomid density and *D. tyrrelli* density exists when the species occur together; that is, it appears that larger copepods prey on the smaller *D. tyrrelli*.

These effects are similar to well-known and well-documented effects in other regions of the world. In other studies (Anderson 1972; Northcote et al. 1978), stocking fish at high densities was found to reduce the abundance of larger zooplankton species to undetectable levels using standard sampling methods. Fish stocked at high densities in British Columbian lakes were found to selectively prey upon a large planktonic larva (Chaoborus), reducing its abundance (Northcote et al. 1978). Two large species of zooplankton, *Diaptomus arcticus* and *Daphnia pulex*, were no longer captured in zooplankton samples in Snowflake Lake (Banff National Park, Canada) after the establishment of high densities of stocked fish (Anderson 1972). Similar effects of stocked fish on large zooplankton species have been observed in other mountain lakes, typically under conditions of high fish density (Crumb 1978; Divens et al. 2001; Donald et al. 1994; Leavitt et al. 1994).

Also similar to the OSU/USGS research, a study of *D. kenai* in a mountain lake in the Olympic Mountains of Washington found that it coexisted in mountain lakes with low densities of stocked salmonids more than 20 years after the fish were initially stocked (WESI 1993). Other studies have documented the coexistence of large diaptomids with low densities of stocked salmonids (Hoffman and Pilliod 1999; Bahls 1990; Anderson 1972; McNaught et al. 1999).

Salmonid: Member of the family of fish that includes trout, salmon, whitefish, and char.

The indirect effect of fish predation on large copepods in increasing the density of smaller species of zooplankton is also known to occur in other mountain lake communities outside the study area (Paul and Schindler 1994; Gliwicz and Rowan 1984). Earlier studies (Anderson 1972; Crumb 1978; Northcote et al. 1978) documented a shift in dominant zooplankton in mountain lakes from large to smaller species following the stocking of salmonids, although total zooplankton abundance was not affected. In mountain lakes that were temporarily stocked with nonreproducing salmonids, the majority of lakes sampled showed that populations of large zooplankton were significantly reduced; however, the population density increased in an apparent rebound after fish were gone or reduced in abundance (Nilsson and Pejler 1973; Divens et al. 2001).

Substrate: The nonliving material or base upon which plants or animals live and grow.

Macroinvertebrates. Macroinvertebrates are an important food source for salamanders and fish in mountain lakes in the study area, and these vertebrate predators can, in turn, affect densities of macroinvertebrate prey. For example, one study (Reimers 1958) found that brook trout under conditions of extreme fish density were able to deplete mayfly and caddisfly populations in a small, high-altitude lake in the eastern Sierra Nevada in California. Fish also induce changes in behavior of nearshore macroinvertebrates; for example, stoneflies select darker substrates and change their activity patterns during the day in the presence of fish (Feltmate and Williams 1989; Feltmate et al. 1992). In the study area, it appears that vertebrate predators may affect the distribution of 3 of 15 nearshore macroinvertebrates: the stonefly, mayfly, and caddisfly. The larval stonefly was far less abundant in lakes with vertebrate predators, though the role of fish predation in reducing its abundance could not be determined. The mayfly was found almost exclusively in lakes without salamanders or fish, but salamander predation, not fish predation, appeared to limit its distribution. Only the caddisfly appeared to be limited by fish predation (Liss et al. 1995).

pH: The measure of the alkalinity or acidity of a substance such as water or soil.

In the study area, the mean number of nearshore macroinvertebrate taxa inhabiting a lake was directly related to maximum temperature. The higher the maximum temperature, which is also associated with lower elevations, the higher the species richness of macroinvertebrates. Water chemistry, pH in particular, and the type of substrate were also important. In other studies (Bell 1991; Schell and Kerekes 1989), the level of successful emergence in aquatic insects and species richness of macroinvertebrates in lakes have all been shown to be positively correlated with pH. Generally, taxa associated with organic substrates are found in lower elevation lakes and those with inorganic substrates at higher elevations.

Researchers at lakes in the North Cascades Complex generally did not analyze the impact of fish or amphibian predators on macroinvertebrates, but other studies have examined responses of benthic macroinvertebrates to stocked fish (Divens et al. 2001). The effects were found to vary by macroinvertebrate species; however, most coexist with fish although their average size and abundance may decline (Olive 1953; Reimers 1958; Walters and Vincent 1973). As with zooplankton, larger macroinvertebrate species are more vulnerable, and higher densities of fish exert a more substantial impact on benthic macroinvertebrates (Bahls 1990; Reimers 1958; Hoffman and Pilliod 1999). Also, similar to copepods, the presence of refuge habitat (such as wood debris, talus, aquatic vegetation, and cobble along rocky shorelines) can substantially reduce the effects of fish predation on macroinvertebrates (Johnston 1973; Olive 1953). The presence of more terrestrial insects in high-lake ecosystems helps to buffer the impact of non-active fish on benthic macroinvertebrates (Divens et al. 2001) because it has been documented that fish will disproportionately favor terrestrial insects over benthic animals as food items (Norlin 1967).

Amphibians. The effects of stocked fish on the native amphibians of mountain lakes have been studied throughout the mountain west, including Alberta, Canada (Graham et al. 1999; Graham and Powell 1999; Huynh et al. 2002; Fukumoto 1995); Idaho (Pilliod and Peterson 2000; Pilliod and Peterson 2001); California (Jennings 1996; Knapp 1996; Knapp et al. 2001; Knapp and Matthews 1998; Knapp and Matthews 2000; Drost and Fellers 1996; Bradford and Tabatabai

1993); and Montana (Maxell 2000; Funk and Dunlap 1999). In Washington, these effects have been noted on amphibians in Olympic National Park (Adams et al. 2000; Bury et al. 2000) and Mount Rainier National Park (Larson and Hoffman 2002). Much of the available information on the effects on native biota from stocking fish in mountain lakes has been summarized by Divens et al. (2001).

Although lakes in the study area are populated by four frog, one toad, one newt, and two salamander species, in this case researchers focused their efforts on determining the effects of fishery management practices on native vertebrates, specifically the long-toed salamander (*Ambystoma macrodactylum*), a species that is integral to the food web of fishless mountain lakes in the North Cascades Complex. Northwestern salamanders (*A. gracile*) also occur in some of the study area lakes on the slopes west of the hydrologic divide; however, they are not as vulnerable to predation by stocked or reproducing fish. Only long-toed salamanders occupy lakes on the east side. It is rare that the two salamander species occur together in a given area, but when they do, the long-toed salamander tends to occupy smaller, shallower lakes than the northwestern salamander. The long-toed salamander is also found in shallow pools in lake inlet and outlet streams that may not be accessible to fish and in small temporary ponds and seeps near lakes with fish. Northwestern salamanders have a variety of tools to defend themselves against fish predation, including nocturnal activity, noxious secretions, and larger larvae than long-toed salamanders (Liss et al. 1995). These same protective devices are known to exist in Northwestern salamander populations in Mount Rainier National Park (Funk and Dunlap 1999; Bury and Adams 2000; Bury et al. 2000; Stevens-Ayers 1997; Larson and Hoffman 2002; Hoffman et al. 2003).

Rough-skinned newts (*Taricha granulosa*) have usually been documented in the literature to coexist with stocked fish in mountain lakes. This is likely because the skin of both the larvae and adult rough-skinned newt contains a potent toxin (Nussbaum et al. 1983).

The frog species in the study area include Cascades frogs (*Rana cascadae*), Columbia spotted frogs (*Rana luteiventris*), northern red-legged frogs (*Rana aurora aurora*), and Pacific tree frogs (*Pseudacris regilla*). Western toads (*Bufo boreas*) have also been documented in the North Cascades Complex. Only a few populations of Cascades frogs have been reported in the North Cascades Complex (Bury and Adams 2000; Bury et al. 2000). In other parts of Washington, Cascades frogs do not occur in deeper lakes and ponds containing fish, suggesting they are vulnerable to predation. In these same areas, the species was common in shallower lakes and ponds where no fish were present. A few populations of Columbia spotted frogs, northern red-legged frogs, western toads, and Pacific tree frogs have been documented in the North Cascades Complex, but most populations are in lower lakes and beaver pond habitats in the lower valleys (Bury and Adams 2000; Bury et al. 2000). Populations of these species, along with rough-skinned newts, appear to be rare and highly fragmented in lakes and ponds within the North Cascades Complex, regardless of the presence of fish (Bury 2002). Cascades frogs, Columbia spotted frogs, northern red-legged frogs, and Western toads are all federal species of concern, which is an informal designation that means population sizes are decreasing, and they are being

Species of Concern: A species that might be in need of concentrated conservation actions, which can vary depending on the health of the species' population and degree and types of threats.

monitored for possible listing as threatened or endangered in the future. The North Cascades Complex is near the edge of the range for Cascades frogs and Columbia spotted frogs (Bury and Adams 2000; Bury et al. 2000), so it is often very difficult, or even impossible, to attribute the absence of these amphibians to fish presence in some of the North Cascades Complex lakes.

The long-toed salamander is an amphibian known to be important to the ecology of mountain lakes in the study area and one sensitive to the presence of fish. It is an "indicator" species (for example, it is capable of showing early signs of change if fishery management practices change) and was the subject of several biotic research studies in the study area conducted by the OSU/USGS team. The larval stage of the long-toed salamander is the top vertebrate predator in high-elevation fishless lakes in the North Cascades Complex and an integral component of the aquatic food web (Tyler et al. 2002). One abiotic factor, the concentration of TKN (total Kjeldahl nitrogen), appears to be important in determining the density of long-toed salamanders in fishless lakes in the study area (Liss et al. 1995; Liss et al. 1998; Tyler et al. 2002). TKN concentration is a measure of ammonia plus all organically derived nitrogen, and in combination with phosphorus concentrations, is a good indicator of a lake's productivity or the amount of phytoplankton. Where phytoplankton densities are higher, cladoceran zooplankton, which are a primary prey source for long-toed salamanders (and the salamanders themselves), are also more abundant.

The density of long-toed salamanders in lakes where abiotic conditions could support them appears directly related to the fish population. As noted above, reproducing populations of fish in study area lakes tended to be denser than stocked (nonreproducing) populations, and they also have a wider variety of size and age classes, with the capacity to exert a more sustained and broad-ranging predation pressure on salamander larvae. Data collected from a sample of lakes in the study area showed the average density of long-toed salamanders in fishless lakes where TKN levels (0.045 mg/L [milligrams per liter] or higher) would sustain them is about 24 per 328 feet of shoreline. The average density of long-toed salamanders for all fishless lakes studied in the North Cascades Complex regardless of TKN levels is 13.2 per 328 feet of shoreline (Tyler et al. 1998a, 1998b). The average density of salamanders in study area lakes with nonreproducing fish is 3.47 per 328 feet of shoreline, and for lakes with reproducing fish, it is 0.1310 per 328 feet of shoreline. Researchers also found more larval salamanders under woody debris or rocks or engaging in other "hiding" behaviors when these refuges were available and fish were present (Tyler et al. 2002).

The OSU/USGS team also compared the density of long-toed salamanders in fishless lakes, lakes with reproducing populations of fish, and lakes with nonreproducing populations of fish that had high, medium, or low concentrations of TKN. They found no difference in the density of salamanders when TKN levels were low (less than 0.045 mg/L), which is probably because salamanders require a certain TKN concentration before they can occupy a habitat. At medium levels of TKN (between 0.055 mg/L and 0.09 mg/L), they did find a significant difference in the density of long-toed salamanders in fishless lakes compared to those lakes with reproducing populations, but not between fishless lakes and those with nonreproducing populations of fish (normally fewer fish). In

lakes where TKN levels were high (above 0.09 mg/L), however, researchers found the density of salamanders at fishless lakes compared to those with nonreproducing populations of fish to be significantly different (Liss et al. 1998; Tyler et al. 2002). One way to interpret this information is to say that lakes with very high TKN levels can support very high densities of long-toed salamanders. When even low levels of fish are introduced into these lakes, they can reduce these salamander densities enough that it is statistically noticeable.

Researchers also noted that these denser or larger populations of salamanders may be particularly important in the study area because they are less vulnerable to extinction from unpredictable events and can serve as important sources of colonists to reestablish extinct local populations (Tyler et al. 2002). These core populations and the satellite colonies that draw from them are called metapopulations.

Metapopulation: Geographically separate populations of the same species that are connected by infrequent, but critical, interbreeding.

Although studies of long-toed salamanders and stocked fish in other areas in the region were not as complex, they did support the conclusions reached by the OSU/USGS team that fish can affect the density of salamander populations. For example, surveys in Olympic National Park found few or no long-toed salamanders in lakes containing fish, but many populations in shallow ponds and lakes without fish (Bury and Adams 2000; Bury et al. 2000; Adams et al. 2000). The authors, as did researchers in the study area, concluded that long-toed salamanders may be able to regionally coexist with fish by using temporary wetlands and other fishless habitat as breeding sites (Bury and Adams 2000; Bury et al. 2000).

Overall, the OSU/USGS team concluded that lakes with relatively high TKN concentrations (about 0.55 mg/L or greater), and those with warmer temperatures (greater than about 54°F), were favored by native biota such as phytoplankton, large copepods, and long-toed salamanders. The aquatic life in these "more productive" lakes could therefore be at highest risk of impact from high densities of reproducing fish and may benefit most from fish removal. For additional information on the OSU/USGS research, see the section titled "Application of Research" in the "Alternatives" chapter.

SCOPING PROCESS AND PUBLIC PARTICIPATION

Public scoping began on January 16, 2003, with the publication of a notice of intent in the *Federal Register*. Four public scoping meetings were held in March of 2003 in these Washington State communities: Sedro-Woolley, March 18; Wenatchee, March 20; Bellevue, March 25; and Seattle, March 27. Approximately 72 people attended the four meetings, and 190 comments were received. In response to public input and issues expressed during the scoping process, the interdisciplinary planning team reworked the preliminary alternatives to those analyzed in this plan/EIS.

ISSUES AND IMPACT TOPICS

Issues are problems, opportunities, and concerns regarding the current and potential future management concepts for managing aquatic resources, impacts of anglers, and sport-fishing opportunities in the 91 mountain lakes that are included in this plan/EIS. The issues were identified by the NPS, WDFW, other agencies, and the public throughout the scoping process. The impact topics are a more refined set of concerns that were analyzed for each of the management alternatives. The impact topics were derived from issues, and in the "Environmental Consequences" chapter, the impact topics were used to examine the extent to which a problem would be made better or worse by the actions of a particular alternative. A summary of the agency and public scoping activities is available in the "Consultation and Coordination" chapter.

AQUATIC ORGANISMS

As described above in the "Summary of Existing Research" section, impacts on aquatic organisms in a lake food web take the form of impacts on individual components of each trophic level. Phytoplankton, zooplankton, macroinvertebrates, and fish are all components of the food web (for an informative description of the food web, see the "Affected Environment" chapter). The specific problems that might occur from fishery management practices are described in the following paragraphs:

Plankton. Under some alternatives, certain lakes may continue to be stocked or would continue to host reproducing fish. Other alternatives may involve removing fish. Fish, especially dense reproducing populations, consume zooplankton and may reduce the numbers, and possibly the presence, of some planktonic species in lakes. Waste products from fish may change the nutrient balance of a lake, which may create a favorable condition for some organisms, causing increases in their numbers. As noted above in the "Summary of Existing Research" section, fish may feed on larger zooplankton, which can in turn allow smaller herbivorous zooplankton to flourish with resulting impacts on phytoplankton and lake productivity and chemistry. The presence of reproducing fish, therefore, could result in a change in the abundance of various organisms and a change in the food web as to which organisms are dominant. Because many other factors affect the numbers and interactions of organisms, the change caused by fish may be outside the range of natural variation over time within the lake or in similar lakes. These effects may be notable among planktonic organisms.

Natural Variation: The changes that occur naturally in an ecosystem (includes physical characteristics, plants, and animals) over time without human disturbance.

Macroinvertebrates. Macroinvertebrates (such as aquatic insects, worms, and snails) consume phytoplankton and zooplankton, as well as periphyton (microscopic algae growing on a lake substrate such as rocks or sediment or on larger plant surfaces), detritus (dead plant and animal material that drifts to the bottom of a lake if it is not consumed), and aquatic plants. Macroinvertebrates are eaten by top predators (including salamanders and fish) in a lake system. Fishery management practices, especially those resulting in high densities of fish over a long period of time, can reduce or eliminate some species of macroinvertebrates, with resulting impacts on salamanders, plankton, detritus, and nutrient concentrations and on the fish population itself. In addition to these generic effects on aquatic food webs, there is a particular interest in a blind amphipod that is found in two mountain lakes in the North Cascades Complex. Although this amphipod could be unique and rare in the North Cascades Complex, neither the U.S. Fish and Wildlife Service nor the WDFW has plans to designate or list this species.

Amphibians. As noted above, salamanders are the natural top vertebrate predator in many of the mountain lakes in the study area. When these lakes are stocked with fish, the number of salamanders drops, presumably because fish eat salamander larvae. Long-toed salamanders, which historically occupied several naturally fishless lakes on the east side of the study area and some lakes on the west side, are particularly vulnerable to predation from stocked fish because they do not have the variety of tools (such as noxious secretions or larger larvae) to defend themselves as do Northwestern salamanders. When salamanders are eliminated or greatly reduced by fish, the aquatic food web is also changed. For example, the type of zooplankton that salamanders normally consume would increase, especially compared to the type of zooplankton that fish consume.

Fish. Stocked fish also can affect native fish species. Hatchery-raised fish of most species are genetically different and usually weaker and less able to survive harsh environmental conditions than native species. If fish escape from lakes into streams that are occupied by native fish of the same species, interbreeding may adversely affect the adaptive characteristics of the native population. Interbreeding can also occur between some fish species (brook and bull trout, for example), eliminating the purity of a native fish species, subspecies, or evolutionarily significant unit of fish. In the extreme, this could result in the localized elimination of that species or subspecies in a lake, park, or region. Escaping fish may also prey on native fish species and compete with native fish for food or habitat.

OTHER WILDLIFE

Fish-eating (piscivorous) wildlife have benefited from stocked fish at a number of lakes in the North Cascades Complex. Mergansers (*Lophodytes cucullatus*, *Mergus merganser,* and *M. serrator*), ospreys (*Pandion haliaetus*), bald eagles

(*Haliaeetus leucocephalus*), belted kingfishers (*Ceryle alcyon*), common loons (*Gavia immer*), and river otters (*Lutra canadensis*) have been observed at mountain lakes. Also, if there is an opportunity, carnivores such as black bears (*Euarctos americanus*), Cascade red foxes (*Vulpes fulva cascadensis*), wolves (*Canis lupus*), raccoons (*Procyon lotor*), mink (*Mustela vison*), and coyotes (*Canis latrans*) will feed on spawning fish in shallow tributary streams in the North Cascades Complex, but they do not depend on stocked fish as a primary food source. If fish are removed, or the density decreased, individuals of these species will either find alternative food sources or relocate to another habitat. In the extreme, if habitat is not available, individuals may be eliminated.

Anglers and other recreationists, as well as stocking or fish removal activities, may temporarily disturb wildlife through the presence of humans and noise.

SPECIAL STATUS SPECIES

Plants. No plants with formal federal special status would be affected by management actions, but several species with state special status or considered sensitive or rare do grow in the study area and may be inadvertently trampled by recreationists, including anglers.

Fish. The genetic integrity and ability to reproduce in bull trout may be affected if stocked brook trout escape from lakes and move to downstream drainages occupied by bull trout. It is also possible that stocked fish migrating from lakes to downstream drainages containing Chinook or Coho salmon might compete with and adversely affect these species. Westslope cutthroat trout are native to stream basins on the east side of the Cascade Crest where they have been replaced or adversely affected through competition and hybridization with stocked rainbow trout dispersing downstream.

Amphibians. Cascades frogs, Columbia spotted frogs, and northern red-legged frogs are species that occupy lake habitat and may be subject to predation by fish. Although tailed frogs and western toads also occupy habitat in the study area, either they do not occupy the same habitat as stocked fish, or they are not subject to predation by trout.

Other Vertebrates. Noise from fish stocking or treatment activities to remove fish may result in disturbance or displacement of individuals from several federal species with special status. These include American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, Pacific fisher, marbled murrelet, Northern spotted owl, and Yuma myotis (bat). Bald eagles and Harlequin ducks may experience some changes to their food base (fish for eagles, aquatic invertebrates for ducks) from management decisions.

VEGETATION

Shoreline vegetation around lakes (riparian zones) may be sensitive to trampling by recreationists, and in particular, those attempting to fish, hike, or ride horses around the lakeshore. Vegetation can also be trampled or lost through fishery management actions, the creation of social trails, or by cross-country travel to reach more remote lakes.

In addition to the direct loss of vegetation, trampling can result in changes to soil such as compaction, erosion, and sedimentation. These changes in habitat can keep vegetation from regrowing, particularly in more severe environments (such as the alpine zone) where natural recovery can be quite slow. Erosion and sedimentation can cause increases in turbidity or concentrations of organic matter and nutrients in a naturally nutrient-poor lake environment.

Social Trails: These trails are not part of the formal network of managed trails; rather, they are informal routes that access a variety of backcountry destinations and create visible patterns of human use.

CULTURAL RESOURCES

The areas surrounding or in the vicinity of many lakes in the study area have not been surveyed, but because prehistoric cultures are known to have occupied the areas, they could contain buried archeological resources or historic resources. The use of these areas, especially lakeshores, by anglers, campers, and other recreationists can remove vegetation, increase soil erosion, and increase the chance of exposing these resources to weathering, theft, or vandalism.

VISITOR USE AND EXPERIENCE

Recreational Use. Changes in the fishery management program could disrupt anglers who may have been fishing at certain lakes for several years, or even several generations. Changes in the fishery management program could also affect non-anglers.

Social Values. Stocking fish in remote lakes, most of which are in wilderness, is a practice favored by some and considered undesirable and inappropriate by others. Anglers may have a more utilitarian approach to stocking, whereas conservation groups and conservationists are associated with naturalistic, ecology-based, or social values. While many anglers are also conservationists, there is a distinction between those who value the stocking of lakes for their enjoyment in contrast to those who value the conservation and protection of natural processes.

Wilderness Values. Approximately 93% of the North Cascades Complex lies within designated wilderness. Wilderness extends beyond the border of the North Cascades Complex, encompassing a region of designated wilderness that exceeds 2 million acres. This figure does not include much of the wild, remote Canadian land that borders the park. Some conservation groups and conservationists particularly object to stocking because it is an unnatural practice involving human manipulation of an ecosystem in a national park and a wilderness area. Trails, trampling of vegetation around a lakeshore, or occasional noise associated with stocking practices may be particularly offensive as evidence of human activity in violation of the wilderness values of a primitive and natural experience.

HUMAN HEALTH

Chemicals may be the only feasible way to remove stocked or reproducing fish from some larger, naturally fishless lakes. The NPS proposes to use antimycin to remove fish (antimycin has limited impacts on nontarget species). The required dosage of antimycin would be very small, and the only pathway for human exposure would be through consumption of treated fish, which is unlikely. Nonetheless, there are public concerns regarding human exposure to antimycin through the consumption of treated fish.

Research has shown that fish stocked in these remote high-elevation lakes have been exposed to methyl-mercury and persistent organic pollutants (POPs) deposited from the atmosphere. There is potential for human consumption of methyl-mercury and POP-contaminated fish and, therefore, some level of concern for human exposure to these chemicals through fish consumption.

SOCIOECONOMIC RESOURCES

Some businesses in the region may directly depend on anglers purchasing equipment, food, lodging, and guide services. Changes in the fishery management program could reduce the number of anglers who fish in the North Cascades Complex, thus reducing both direct and indirect economic benefits associated with them.

NORTH CASCADES COMPLEX MANAGEMENT AND OPERATION

Changes in the fishery management program would require NPS involvement to carry out management actions such as monitoring, lake treatments, and restocking. Monitoring and management by NPS and WDFW, in some cases, would require extensive effort and staffing, with resulting changes to the agencies' budgets.

In the past, lakes have been stocked without approval from the NPS and/or WDFW, and in some instances, lakes have been illegally stocked following costly fish removal efforts (for example, Tipsoo Lake at Mount Rainier National Park). In the future, unsanctioned stocking could undo costly fish removal efforts, significantly undermine fishery management activities, and cause a variety of unacceptable ecological impacts.

ISSUES DISMISSED FROM FURTHER CONSIDERATION

Minority and Low-Income Populations (Environmental Justice)

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs federal agencies to address environmental and human health conditions in minority and low-income communities so as to avoid the disproportionate placement of any adverse effects from federal policies and actions on these populations. This topic is dismissed from further consideration for the following reasons:

> Visitors to the North Cascades Complex are not disproportionately minority or low-income.
>
> Minority or low-income populations would not be disproportionately affected by changes in fishery management.

Floodplains

Management actions for fish would have no effect on floodplains.

Special Status Species

Although many wildlife and plant species that are listed as threatened, endangered, or otherwise of special concern do occur in the North Cascades Complex, not all of them occur in habitat included in the study area. The full list of species that occur in the region is included in appendix C. Several special status species in the study area are being analyzed as part of this plan/EIS (refer to the "Issues and Impact Topics" section in this chapter).

Visitor Safety

No impacts on visitor safety or to those park operations that maintain visitor safety, such as search and rescue, are expected to occur from changes in the fishery management program.

Prime and Unique Agricultural Lands

No prime or unique farmlands exist in the North Cascades Complex, and no actions would affect agricultural soils.

RELATED LAWS, POLICIES, PLANS, AND CONSTRAINTS

The following laws, policies, and plans by the NPS, WDFW, or agencies with neighboring land or relevant management authority are described in this section to show the constraints this plan/EIS must operate under and the goals and policies that it must meet. These goals and constraints are summarized in the beginning of this chapter but described in more depth in the following sections.

GUIDING LAWS AND POLICIES

NPS ORGANIC ACT OF 1916

By enacting the *NPS Organic Act of 1916*, Congress directed the U.S. Department of the Interior and the NPS to manage units of the national park system "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of future generations" (16 United States Code [USC] 1). The *Redwood National Park Expansion Act of 1978* reiterates this mandate by stating that the NPS must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 USC 1a-1).

Despite these mandates, the *Organic Act* and its amendments afford the NPS latitude when making resource decisions. By these acts, Congress "empowered [the NPS] with the authority to determine what uses of park resources are proper and what proportion of the parks resources are available for each use" (*Bicycle Trails Council of Marin v. Babbitt*, 82 F.3d 1445, 1453 [9th Cir. 1996]).

Yet, courts have consistently interpreted the *Organic Act* and its amendments to elevate resource conservation above visitor recreation. *Michigan United Conservation Clubs v. Lujan*, 949 F.2d 202, 206 (6th Cir. 1991) states, "Congress placed specific emphasis on conservation." *The National Rifle Association of America v. Potter*, 628 F. Supp. 903, 909 (D.D.C. 1986) states, "In the *Organic Act* Congress speaks of but a single purpose, namely, conservation." The *NPS Management Policies* (NPS 2001a) also recognize that resource conservation takes precedence over visitor recreation. The policy dictates, "when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant."

Because conservation remains predominant, the NPS seeks to avoid or minimize adverse impacts on park resources and values; however, the NPS has discretion to allow negative impacts when necessary to fulfill park purposes (NPS 2001a, 1.4.3).

While some actions and activities cause impacts, the NPS cannot allow an adverse impact that constitutes resource impairment (NPS 2001a, 1.4.3). The *Organic Act* prohibits actions that impair park resources unless a law directly and specifically allows for the acts (16 USC 1a-1). An action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS 2001a, 1.4.4). To determine impairment, the NPS must evaluate "the particular resources and values that would be affected, the severity, duration, and timing of the impact, the direct and indirect effects of the impact, and the cumulative effects of the impact in question and other impacts" (NPS 2001a, 1.4.4). This plan/EIS, therefore, assesses the effects of the management alternatives on park resources and values and determines if these effects would cause impairment.

NPS Management Policies require an analysis of potential effects to determine whether or not actions would impair park resources (NPS 2001a). The fundamental purpose of the national park system is to conserve park resources and values for the use and enjoyment of future generations. NPS managers have the discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values. That discretion to allow certain impacts within the park is limited by the statutory requirement that the NPS must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible manager, would harm the integrity of park resources or values. An impact on any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major adverse effect on a resource or value whose conservation is

> necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park
>
> key to the natural or cultural integrity of the park
>
> identified as a goal in the park's general management plan or other relevant NPS planning documents

NPS MANAGEMENT POLICIES (2001)

Several sections from the *NPS Management Policies* (NPS 2001a) are relevant to fishery management in the North Cascades Complex, as described below.

NPS Management Policies instruct park units to

> maintain as part of the natural ecosystems of parks all native plants and animals by minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them (NPS 2001a, 4.4.1)

> re-establish natural functions and processes in human-disturbed components of natural systems in parks (unless otherwise directed by Congress) (NPS 2001a, 4.1.5). (Human disturbances include the introduction of exotic species and the disruption of natural processes. Using the best available technology and within its staff, funding and other resource constraints, park units are to restore the biological and physical components of these systems.)
>
> seek to return human-disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated" (NPS 2001a, 4.1.5).

As noted above, sport fishing is generally allowed in NPS units unless specifically prohibited, providing it "does not jeopardize natural aquatic ecosystems or riparian zones" (NPS 2001a, 8.2.2.5). At least one-third of the areas administered by the NPS have substantial fish resources and fishery activities. Sport fishing has been permitted in national parks since the establishment of Yellowstone National Park in 1872. Sport fishing is managed under 36 *Code of Federal Regulations* (CFR) 2.3, which states in part, "fishing shall be in accordance with the laws and regulation of the State . . . *Non-conflicting* State laws are adopted as part of these regulations." The NPS is allowed to restrict fishing activities wherever needed to achieve its own management objectives.

In contrast to sport fishing, the practice of stocking fish is generally prohibited in park units. Stocking cannot "impair park natural resources or processes," and it must take place only in national recreation areas or preserves that have historically been stocked (only the same species that has historically been stocked may continue to be stocked) (NPS 2001a, 4.4.3). Exotic species cannot displace native species (if displacement can be prevented), and parks are to manage "up to and including eradication" if control is feasible and the exotic species interferes with native species, natural habitats, or disrupts the integrity of the native species (NPS 2001a, 4.4.4.2). If an exotic species is introduced or maintained to meet specific NPS management needs, all "feasible and prudent measures to minimize the risk of harm" to native biota or invasion of habitat by the exotic species must be taken, and the exotic species must "be known to be historically significant, to have existed in the park during the park's period of historical significance, or to have been commonly used in the local area at that time" (NPS 2001a, 4.4.4.1). Because stocking in the North Cascades Complex has not met all of these conditions, a policy waiver from the director of the NPS has been required to continue stocking (see the "History of Fish Management in North Cascades Mountain Lakes" section in this chapter). For more information, see "Appendix D: Related Regulations, Policies, Laws, and Legislation."

DIRECTOR'S ORDER 12: CONSERVATION PLANNING, ENVIRONMENTAL IMPACT ANALYSIS, AND DECISION MAKING AND HANDBOOK

NPS *Director's Order 12* and Handbook (NPS 2001b) lay the groundwork for how the NPS complies with the *National Environmental Policy Act* (NEPA). *Director's Order 12* and Handbook set forth a planning process for incorporating scientific and technical information and establishing a solid administrative record for NPS projects.

NPS *Director's Order 12* requires that impacts on park resources be analyzed in terms of their context, duration, and intensity. It is crucial for the public and decision makers to understand the implications of those impacts in the short and long term, cumulatively, and within context, based on an understanding and interpretation by resource professionals and specialists. *Director's Order 12* also requires that an analysis of impairment of park resources and values be made as part of the NEPA document.

NORTH CASCADES NATIONAL PARK SERVICE COMPLEX ENABLING LEGISLATION (PUBLIC LAW 90-544)

Each NPS unit is guided by the *Organic Act*, *NPS Management Policies*, the *National Environmental Policy Act*, and other laws and policies, but each unit also has more specific guidance provided by its own enabling legislation; statements of mission, purpose, and significance; and broad planning documents such as a general management plan and strategic plan. These documents, and how they relate to the North Cascades Complex, are summarized in the following sections.

The North Cascades National Park was established in 1968 by an act of Congress (PL 90-544) "in order to preserve for the benefit, use, and inspiration of present and future generations certain majestic mountain scenery, snowfields, glaciers, alpine meadows, and other unique natural features in the North Cascade Mountains of the State of Washington" (82 Stat. 926).

The Ross Lake National Recreation Area was created "in order to provide for the public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge Lakes, together with the surrounding lands, and for the conservation of the scenic, scientific, historic, and other values contributing to public enjoyment of such lands and waters" (82 Stat. 927).

The Lake Chelan National Recreation Area was created "in order to provide for the public outdoor recreation use and enjoyment of portions of the Stehekin River and Lake Chelan, together with the surrounding lands, and for the conservation of the scenic, scientific, historic, and other values contributing to public enjoyment of such lands and waters."

The following key administrative provisions of the 1968 legislation related to this current planning effort are:

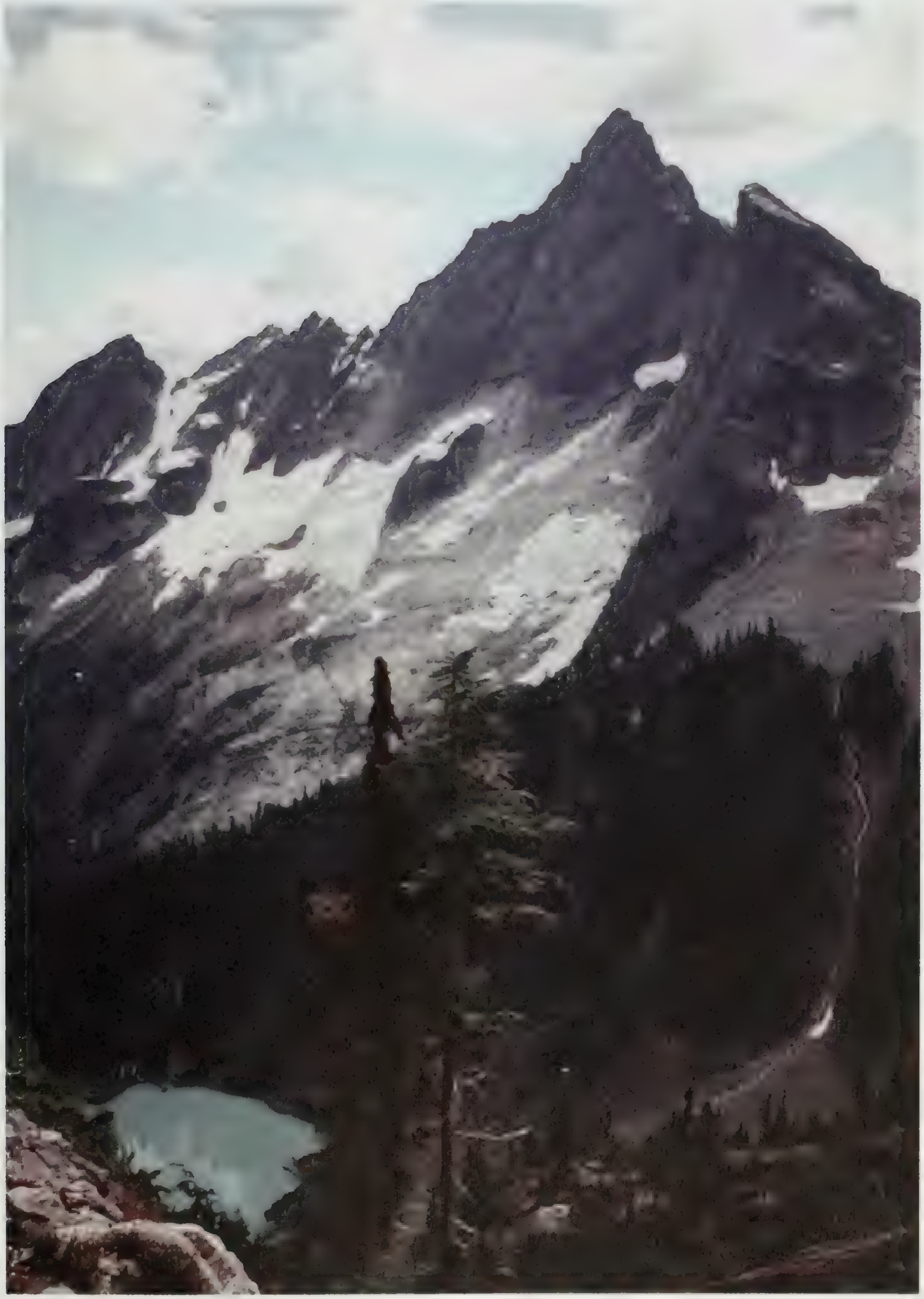
> The Secretary of the Interior shall administer the recreation areas in a manner which in his judgment will best provide for (1) public outdoor recreation benefits, (2) conservation of scenic, scientific, historic, and other values contributing to public enjoyment, and (3) such management, utilization, and disposal of renewable natural resources and the continuation of such existing uses and developments as will promote or are compatible with, or do not significantly impair, public recreation and conservation of the scenic, scientific, historic, or other values contributing to public enjoyment.
>
> The Secretary shall permit hunting and fishing on lands and waters under his jurisdiction within the boundaries of the recreation areas in accordance with applicable laws of the United States and of the State of Washington, except that the Secretary may designate zones where, and establish periods when, no hunting or fishing shall be permitted for reasons of public safety, administration, fish and wildlife management, or public use and enjoyment. Except in emergencies, any regulations of the Secretary pursuant to this section shall be put into effect only after consultation with the Department of Game [now the WDFW] of the State of Washington.

Purpose and Significance of North Cascades National Park Service Complex

The purpose and significance of the North Cascades Complex comes from its enabling legislation and *NPS Management Policies*. The North Cascades Complex's enabling legislation, mission, and its purpose and significance provide a framework for addressing mountain lakes fishery management within the North Cascades Complex. The purpose, need, objectives, and range of alternatives presented in this plan/EIS are grounded in the North Cascades Complex's purpose and mission.

The mission statement of the North Cascades Complex is that it "is dedicated to conserving, unimpaired, the natural and cultural resources and values of North Cascades National Park, Ross Lake National Recreation Area and Lake Chelan National Recreation Area for the enjoyment, education, and inspiration of this and future generations. The North Cascades Complex also shares responsibility for advancing a great variety of national and international programs designed to extend the benefits of natural and cultural resource conservation and outdoor recreation."

"To preserve for the benefit, use, and inspiration of present and future generations certain majestic mountain scenery, snowfields, glaciers, alpine meadows, and other unique natural features, biological processes, and cultural resources in the North Cascades" (Strategic Plan for North Cascades National Park Service Complex).



The purpose of the North Cascades Complex as stated in the *Strategic Plan* (NPS 2000a) is as follows:

> To preserve for the benefit, use, and inspiration of present and future generations certain majestic mountain scenery, snowfields, glaciers, alpine meadows, and other unique natural features, biological processes, and cultural resources in the North Cascades.
>
> To provide outdoor recreation use and enjoyment for the public, and for the conservation of the scenic, scientific, historic, and other values contributing to public enjoyment within Ross Lake and Lake Chelan National Recreation Areas.
>
> To preserve and protect the lands legislatively designated as the Stephen T. Mather Wilderness for use and enjoyment of the public in a manner that will leave them unimpaired for future use and enjoyment as wilderness.

The significance of the North Cascades Complex as stated in the *Strategic Plan* (NPS 2000a) is as follows:

> The North Cascades Complex contains more glaciers than any other national park in the United States outside Alaska. The North Cascades ecosystem has over half the glaciers in the lower 48 states. These glaciers are an important source of water for salmon, other wildlife, plants, and people in the Puget Sound region.
>
> The 9,000-plus feet of vertical relief, and the great contrast between climates east and west of the Cascade Crest, provide habitat for one of the greatest diversities in North America and for varied fauna including rare and sensitive species.
>
> The variety of waters (lakes and rivers) and topography provides a large and expanding nearby population with a wide array of recreational opportunities, from boating and camping to climbing and backpacking.
>
> The North Cascades Complex, which adjoins public lands preserved in Canada, is the core of one of the largest protected wild areas in the United States, a substantial portion of it is designated Wilderness.
>
> The North Cascades Complex contains structures or sites that are on the National Register of Historic Places and others that are eligible for listing on the National Register, 3 historic districts, and over 250 archeological sites. The North Cascades Complex was once home to at least four tribes whose descendants now live nearby and includes, within its boundaries, three contemporary communities.

PLANNING DOCUMENTS FOR NORTH CASCADES NATIONAL PARK SERVICE COMPLEX

GENERAL MANAGEMENT PLAN

The *North Cascades National Park Service Complex General Management Plan* (NPS 1988b) includes management guidance for North Cascades National Park and Ross Lake and Lake Chelan National Recreation Areas, and that management guidance is relevant to the objectives of this plan/EIS. For natural resources in the North Cascades Complex, the *General Management Plan* stresses increasing knowledge and understanding of the interrelationships of natural processes, preserving and restoring natural resources as part of a regional ecosystem, and providing research opportunities in "as natural a system as possible." For the national recreation areas, the policy statements are similar regarding natural resources, calling on the NPS to conserve scenic and primary natural resources, but also to balance ecological processes with recreational activities. For the Ross Lake National Recreation Area, the *General Management Plan* states that this balance should be maintained to provide "the closest natural resource condition consistent with recreational use and existing power development." For the Lake Chelan National Recreation Area, the *General Management Plan* says "to conserve the scenic and the natural resources and to balance ecological relationships and processes with recreational activities in order to maintain the closest natural resource condition consistent with recreational use and the Stehekin community."

The *General Management Plan* speaks of the need for cooperation with agencies, residents, organizations, and the public to ensure land use in and adjacent to North Cascades Complex is compatible with park purposes to the greatest extent possible, to develop resource management programs, and to develop plans and programs to deal with any other problems of mutual concern.

STRATEGIC PLAN

The *Strategic Plan for the North Cascades National Park Service Complex* (NPS 2000a) includes goals for preserving park resources that are consistent with the goals and objectives of this plan/EIS.

Mission Goal I.a. states that

> Natural and cultural resources and associated values of the North Cascades National Park Service Complex are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context.

Mission Goal I.b. states that

> The National Park Service at the North Cascades National Park Service Complex contributes to knowledge about natural and

cultural resources and their associated values, management decisions about resources and visitors are based on adequate scholarly and scientific information.

Subgoals on species inventories and species abundance and distribution are furthered by the information contained in this plan/EIS.

RESOURCE MANAGEMENT PLAN

The *Resource Management Plan for North Cascades National Park Service Complex* (NPS 1999a) is an internal North Cascades Complex document that elaborates on the resource conditions and management strategies set in the *General Management Plan* (1988b) described above. The primary purpose of the *Resource Management Plan* is to develop a program to achieve the mission related to natural and cultural resource stewardship. The *Resource Management Plan* contains individual project statements that describe the existing resource conditions and how they differ from the desired conditions. The plan then outlines a strategy for addressing each resource issue. With regard to fish stocking of natural lakes, the plan describes the following tasks:

conducting fish impact evaluation

refining risk criteria to native biota

preparing a fishery management plan and NEPA review (in accordance with the 1991 Consent Decree described earlier in this chapter)

implementing the plan including monitoring and mitigation

MANAGEMENT IN WILDERNESS

WASHINGTON PARKS WILDERNESS ACT AND THE WILDERNESS ACT OF 1964

The federal *Washington Parks Wilderness Act* signed into law by Congress on November 16, 1988 (100 PL 668, 1988), created approximately 634,614 acres of wilderness and approximately 5,226 acres of potential wilderness within the North Cascades Complex, which is now known as the Stephen T. Mather Wilderness. This designation encompassed over 93% of the North Cascades Complex.

In designating these areas as wilderness, Congress extended all of the protections and mandates of the *Wilderness Act of 1964* (16 USC 1131 et seq.). The *Wilderness Act* established a national wilderness preservation system, "administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness" (16 USC 1131). The *Wilderness Act* defines

wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." An area of wilderness is further defined to mean "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable, (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation, (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value" (16 USC 1131).

With regard to designated wilderness, section 6.4.3 of the *NPS Management Policies* (NPS 2001a) states, "Recreational uses in National Park Service wilderness areas will be of a nature that enables the areas to retain their primeval character and influence, protect and preserve natural conditions, leave the imprint of man's work substantially unnoticeable, provide outstanding opportunities for solitude or primitive and unconfined types of recreation, and preserve wilderness in unimpaired condition."

Lands in the study area that are also in designated wilderness are more restricted in the kinds of uses that can take place because of the *Wilderness Act* requirements. These restrictions include the tools the park is able to use to conduct fishery management practices. For more information, see "Appendix D: Related Regulations, Policies, Laws, and Legislation."

WILDERNESS MANAGEMENT PLAN

The *Wilderness Management Plan* (NPS 1989) outlines how the NPS will manage wilderness in the North Cascades Complex according to a "limits of acceptable change" approach. The plan governs use of the wilderness by all visitors, including anglers, but does not address fishery management. The *Wilderness Management Plan* divides the park and recreation areas into four opportunity classes (backcountry use zones): Day Use, Trailed/Established Camp, Cross Country I, and Cross Country II. Within these zones, limits are set on use numbers, and thresholds are established for impacts. These use numbers are maintained through the requirement of a permit for backcountry camping.

RELATED LEGISLATION AND POLICIES

Washington State Environmental Policy Act (SEPA)

The state of Washington has a *State Environmental Policy Act* (SEPA), enacted in 1971, that parallels the *National Environmental Policy Act*. While the *National Environmental Policy Act* applies to federal agencies and actions, the *Washington State Environmental Policy Act* applies to state and local agency actions that may have a significant effect on the quality of the environment (unless those actions

are defined as exempt by the state). Some undertakings require both federal and state or local actions and, therefore, are subject to both the *National Environmental Policy Act* and *State Environmental Policy Act*. This plan/EIS has been prepared as a NEPA document and may subsequently be adopted by the state of Washington prior to its taking action on this document.

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE GOALS, POLICIES, AND OBJECTIVES

The WDFW manages fish resources throughout the state, including those in the North Cascades Complex and surrounding public lands administered by the U.S. Department of Agricultural-U.S. Forest Service (National Forests System lands and wilderness areas). The goals, policies, and objectives of the WDFW guide that management (WDFW 1995). The WDFW's high lakes fishery management program applies to all of the lakes in the lands surrounding the North Cascades Complex (for a discussion of the history of this program, see WDFW 2001). Inside the North Cascades Complex, authority for fish management is shared with the park.

STATEWIDE FISH POLICY

The Washington Fish and Wildlife Commission is the supervising authority for the WDFW. The department's goals, policies, and objectives were published on February 2, 1995 (WDFW 1995).

The WDFW's mission is sound stewardship of fish and wildlife. Goals in pursuit of this mission include "Maximizing fishing, hunting, and nonconsumptive recreational opportunities compatible with healthy, diverse fish and wildlife populations," and "Maximizing recreational opportunity for fish and wildlife constituents consistent with the preservation, protection, and perpetuation of the fish and wildlife resources." Goals specific to fish management include "providing for significant recreation opportunities through artificial propagation programs" and "maximize[ing] fish and recreation opportunities."

One of the objectives under the goal of maximizing sport fishing opportunities is to implement "balanced management strategies that provide for a variety of recreational activities including unique fishing opportunities and optimum harvest." A related objective directs the department to "maintain maximum recreation through population manipulations with the use of stocked fish, partial treatments with rotenone, and other strategies in appropriate waters."

STATEWIDE FISHING REGULATIONS

Fishing in the North Cascades Complex is governed by Washington State fishing regulations. A state fishing license is required for all persons 15 years or older, and licenses must be carried when fishing, including in the North Cascades Complex. The legal fishing methods and gear are described in the regulations (hook and line only), and using live bait, chemical irritants, or multiple fishing rods is prohibited. Lakes are open to fishing for most species all year. Daily harvest limits are generally five fish, but specific lakes may have a limit of two fish. Some waters have size limits, and special gear limitations are imposed on some waters.

Washington State fishing regulations control catch limit, size, and fishing method for each species. Special rules for individual rivers specify the location, season, catch limit, size, and other unique regulations for the individual river. A summary of the 2004 Washington State freshwater fishing regulations is contained in appendix D (for the complete pamphlet, visit the WDFW website at http://www.wa.gov/wdfw/fish/regs/fishregs.htm).

OTHER FEDERAL AGENCY PLANS, POLICIES, AND ACTIONS

U.S. FOREST SERVICE

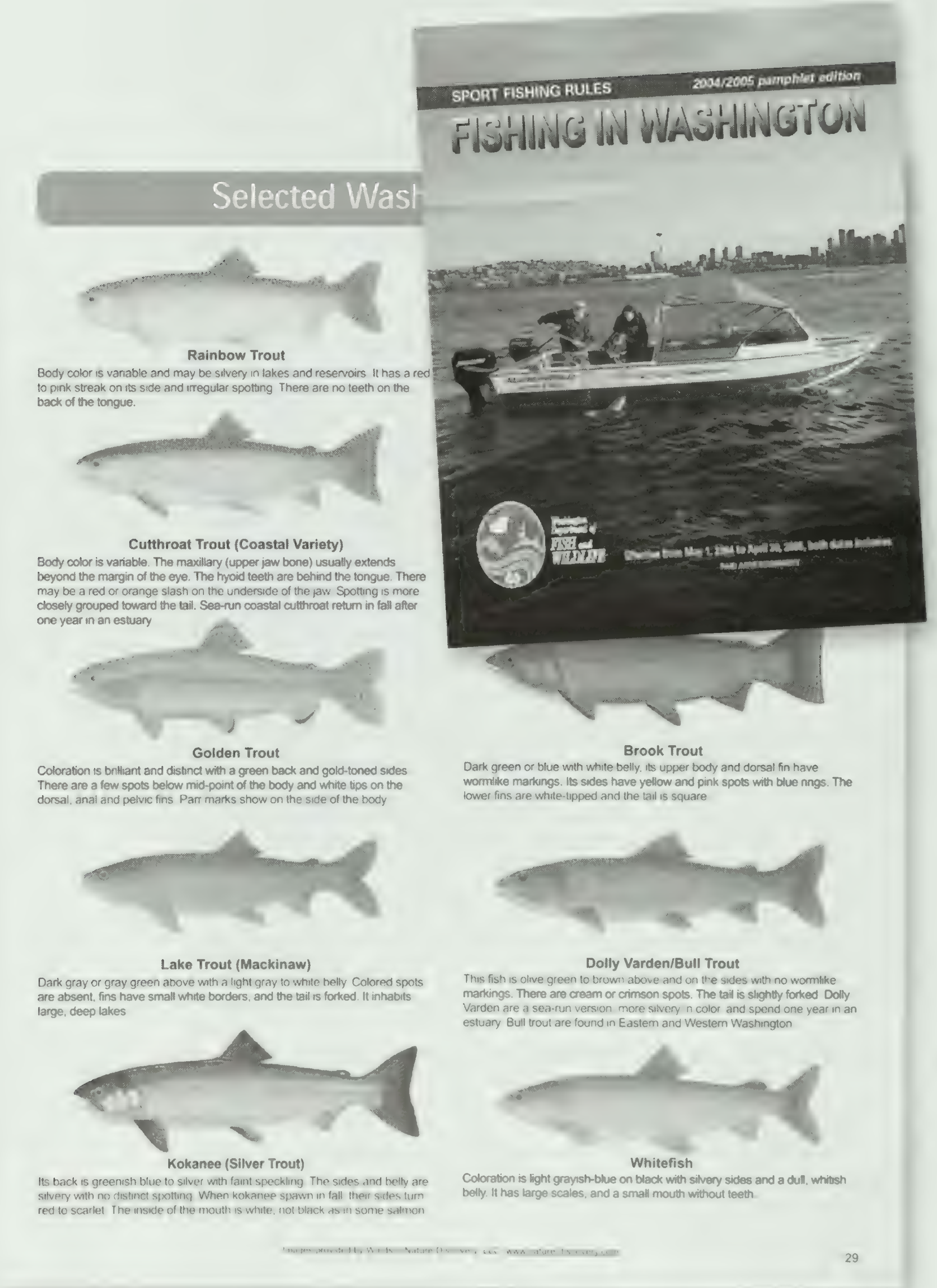
Three national forests are in the region of the North Cascades Complex: Okanogan, Wenatchee, and Mt. Baker-Snoqualmie. While this plan/EIS only covers a study area within the boundaries of lands managed by the NPS, anglers are able to fish in lakes in the neighboring forests and wilderness areas. Should the selected alternative include the removal of stocked or reproducing fish from some of the lakes in the study area, mountain lakes on U.S. Forest Service lands or in Canada are likely to experience increases in use.

U.S. FISH AND WILDLIFE SERVICE

Some fish-bearing lakes in the North Cascades Complex and the surrounding areas drain to waters supporting fish populations currently listed under the *Endangered Species Act*. Pursuant to the Act, management plans for mountain lakes fisheries on federal lands are expected to be consistent with recovery planning goals for listed species. One listed species considered at risk in the study area is the bull trout (*Salvelinus confluentus*). Currently, recovery plans related to the *Endangered Species Act* have been completed in draft form by the U.S. Fish and Wildlife Service for the Puget Sound and Upper Columbia River Recovery Units for the threatened bull trout. Chinook salmon, another listed species, may also be at risk, although the recovery plan for this species is still in development.

NATIONAL MARINE FISHERIES SERVICE

The recovery plan for Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) is currently under development and will be completed by the National Oceanic and Atmospheric Administration Fisheries (National Marine Fisheries Service). This is because Chinook are an anadromous species, meaning they spend some portion of their lives at sea.



SPORT FISHING RULES 2004/2005 pamphlet edition

FISHING IN WASHINGTON

Selected Wash

Rainbow Trout
Body color is variable and may be silvery in lakes and reservoirs. It has a red to pink streak on its side and irregular spotting. There are no teeth on the back of the tongue.

Cutthroat Trout (Coastal Variety)
Body color is variable. The maxillary (upper jaw bone) usually extends beyond the margin of the eye. The hyoid teeth are behind the tongue. There may be a red or orange slash on the underside of the jaw. Spotting is more closely grouped toward the tail. Sea-run coastal cutthroat return in fall after one year in an estuary.

Golden Trout
Coloration is brilliant and distinct with a green back and gold-toned sides. There are a few spots below mid-point of the body and white tips on the dorsal, anal and pelvic fins. Parr marks show on the side of the body.

Lake Trout (Mackinaw)
Dark gray or gray green above with a light gray to white belly. Colored spots are absent, fins have small white borders, and the tail is forked. It inhabits large, deep lakes.

Kokanee (Silver Trout)
Its back is greenish blue to silver with faint speckling. The sides and belly are silvery with no distinct spotting. When kokanee spawn in fall, their sides turn red to scarlet. The inside of the mouth is white, not black as in some salmon.

Brook Trout
Dark green or blue with white belly, its upper body and dorsal fin have wormlike markings. Its sides have yellow and pink spots with blue rings. The lower fins are white-tipped and the tail is square.

Dolly Varden/Bull Trout
This fish is olive green to brown above and on the sides with no wormlike markings. There are cream or crimson spots. The tail is slightly forked. Dolly Varden are a sea-run version, more silvery in color, and spend one year in an estuary. Bull trout are found in Eastern and Western Washington.

Whitefish
Coloration is light grayish-blue on black with silvery sides and a dull, whitish belly. It has large scales, and a small mouth without teeth.

29

LOCAL PLANS AND POLICIES

Although portions of the North Cascades Complex lie within Whatcom, Skagit, and Chelan Counties, the counties do not have planning jurisdiction over these federally managed lands. Any long-range planning efforts of small, unincorporated communities (such as Stehekin and Newhalem) that are within the boundaries of the North Cascades Complex are coordinated between the appropriate county and the NPS.

TRIBAL GOVERNMENT INTERESTS

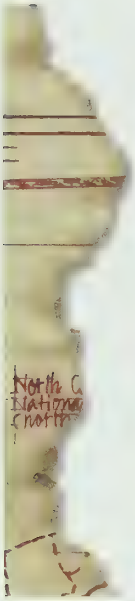
Based on discussions with various tribes affiliated with the North Cascades Complex, there is no indication that Native Americans stocked fish in mountain lakes, although several tribal members suggested it could have been possible. While the mountain lakes fishery is an artifact of contemporary culture, the lakes themselves are very important to various tribes, as documented in the archeological record and in consultation with the tribes. These consultations currently indicate that tribal government interests will be protected provided there is no ground disturbance from management actions. The "Consultation and Coordination" chapter (see the "Native American Tribes" section under "Agency Consultation") lists the tribes that have been consulted.

Canada
Mt. Baker Wilderness
Mt. Shuksan
North C
Nationa
(north
Baker Lake
Skagit River
Marblemount
Sauk River
Suiattle River
Darrington
Boulder River Wilderness
0
5
10
20

Alternatives

Welcome

You are now in the "Alternatives" chapter.
Here are the topics you can read about.



INTRODUCTION 47

STUDY AREA DEFINITION 48

ALTERNATIVES DEVELOPMENT PROCESS 49

ALTERNATIVE A: (NO ACTION) EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH) 72

ELEMENTS COMMON TO ALL ACTION ALTERNATIVES 82

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE) 98

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH) 106

ALTERNATIVE D: 91 LAKES WOULD BE FISHLESS (ENVIRONMENTALLY PREFERRED ALTERNATIVE) 112

ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION 118

CONSISTENCY WITH SECTIONS 101(B) AND 102(1) OF THE NATIONAL ENVIRONMENTAL POLICY ACT 119

ENVIRONMENTALLY PREFERRED ALTERNATIVE 122

INTRODUCTION

This "Alternatives" chapter describes the various actions that could be implemented for current and future management of the mountain lakes fishery in the North Cascades National Park Service Complex (the North Cascades Complex). The *National Environmental Policy Act* (NEPA) requires that federal agencies explore a range of reasonable alternatives and provide an analysis of what impacts the alternatives could have on the natural and human environment. The "Environmental Consequences" chapter of this *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS) presents the results of the analyses. The alternatives under consideration must include a "no-action" alternative as prescribed by 40 *Code of Federal Regulations* (CFR) 1502.14. The no-action alternative in this plan/EIS is the continuation of current management of the mountain lakes fishery, and it assumes that the National Park Service (NPS) would not make major changes to the current fishery management program. The three action alternatives presented in this chapter were derived from the recommendations of the interdisciplinary planning team and through feedback from the public during the public scoping process. The interdisciplinary planning team (also referred to as the Technical Advisory Committee) is comprised of NPS resource specialists, Washington Department of Fish and Wildlife (WDFW) biologists, and other individual resource specialists.

The three action alternatives analyzed in this plan/EIS meet, to a large degree, the management objectives for the North Cascades Complex and also the purpose of and need for action as expressed in the "Purpose of and Need for Action" chapter. Because each of the action alternatives is responsive to the objectives, they are considered "reasonable."

STUDY AREA DEFINITION

The study area for this plan/EIS is the North Cascades Complex (see "Map 1" located in the envelope that accompanied this document) and the 91 naturally formed mountain lakes in the North Cascades Complex that currently have, or at one time had, a fish presence as a result of either documented or undocumented fish stocking activities. Under natural conditions, these 91 mountain lakes would be fishless, but available records indicate these lakes have either been stocked in the past or are stocked now. The records were compiled from databases maintained by the NPS, WDFW, and volunteer groups such as the Washington State Hi-Lakers and Trail Blazers, Inc. Some lakes without a recorded history of fish stocking are included in the study area as well. These are lakes known to contain fish as a result of undocumented stocking by humans or from being connected to a lake or stream that serves as a source of fish. Two fishless lakes that have a history of fish presence (Silver and Pyramid) are in Research Natural Areas. Research Natural Areas were established in the North Cascades Complex's 1988 *General Management Plan* (NPS 1988b) for the purposes of scientific research. A total of 245 mountain lakes are in the North Cascades Complex, and at least 154 of these lakes have always been fishless and would continue to be fishless under any alternative. Because they would remain fishless, and because they have never been part of the managed fishery, these 154 lakes are not analyzed in this plan/EIS.

The 91 lakes addressed in this plan/EIS are dotted throughout the North Cascades Complex: 7 are in Ross Lake National Recreation Area, 15 are in Lake Chelan National Recreation Area, and 69 are located in the North Cascades National Park (see "Map 1" in the envelope that accompanied this document). Of the 91 lakes in the study area, 90 lakes are located in designated wilderness (Stephen T. Mather Wilderness) that overlays approximately 93% of the North Cascades Complex.

Historically, all mountain lakes in the North Cascades Complex, including the 91 lakes defined for this analysis, were naturally fishless. The fish species currently present in these lakes are not native to the lakes in accordance with *NPS Management Policies* (NPS 2001a) that define nonnative species. However, some native fish species (native to the watershed and streams) reside in the streams connected to the lakes. For instance, species of fish, such as bull trout, cutthroat trout, and rainbow trout, are native to the streams in the study area. Notable aquatic species native to mountain lakes include the long-toed salamander, the Northwestern salamander, and certain species of planktonic organisms and macroinvertebrates because they were present naturally prior to fish stocking.

ALTERNATIVES DEVELOPMENT PROCESS

OVERVIEW OF ALTERNATIVES

The management actions are discussed in detail in this chapter under the sections titled "Development of Management Actions for Alternatives B and C" and "Management Actions." The management actions were applied to each of the alternatives as follows:

Alternative A: No Action—Existing Management Framework of 91 Lakes (62 Lakes Have Fish). No new management actions were applied. This alternative assumes that the current management decisions, without any new criteria or factors, would continue.

Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative). The management actions were applied on a lake-by-lake basis over the entire study area using the approach described below in the section titled "Development of Management Actions for Alternatives B and C." The emphasis of alternative B would be to eliminate high-density reproducing fish from study area lakes in order to more closely approximate natural biological conditions. Fish would occur in lakes where impacts on biological resources from low-density reproducing or nonreproducing fish populations could be minimized.

Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish). The goal of alternative C is that 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish, and 2 lakes would be evaluated for restocking. The other 11 lakes in the national recreation areas either would remain fishless or become fishless. The 69 lakes in the national park would be returned to their natural fishless condition or would remain fishless. These actions would bring high alpine lake management in the North Cascades Complex more in line with current NPS management practices. While *NPS Management Policies* (NPS 2001a, 4.4.4.1) state that in general, "exotic species will not be introduced into parks," policies also state, "in some situations, the Park Service may stock native or exotic animals for recreational harvesting purposes, but only when . . . such stocking is in a national recreation area or preserve that has historically been stocked" (NPS 2001a, 4.4.3). Fish would be allowed in national recreation area lakes where impacts on biological resources from low-density reproducing or nonreproducing fish populations could be minimized (NPS 2001a).

Green Lake, Green Lake with Bacon Peak in the background, Wilcox Lakes, and Coon Lake.

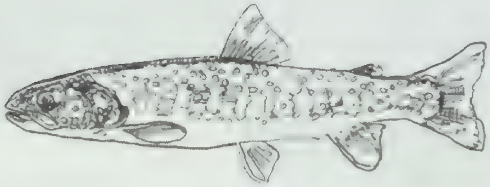
Alternative D: 91 Lakes Would Be Fishless (Environmentally Preferred Alternative). The goal is that all 91 lakes in the study area would be fishless. Fish would be eliminated (to the extent feasible) in lakes that currently contain fish, and lakes that are now fishless would remain fishless.

The following sections describe in detail how these alternatives were developed.

REVIEW OF EXISTING DATA

Biota: The combined plant and animal life of a particular region.

As described in the "Purpose of and Need for Action" chapter, preparation of this plan/EIS was to begin upon completion of a 12-year research program initiated by Oregon State University (OSU) in 1988. While the majority of research from 1988 to date focused on the effects of fish stocking on native biota in mountain lakes, other information important to fishery management has been developed during this time. Over the past several years, species of special concern and new listings of threatened and endangered species, such as the bull trout, have created the need for additional management of mountain lakes to ensure species were not being inadvertently affected by fishery management. The primary user groups of the mountain lakes fishery have also collected data important to understanding the use of this resource. Information obtained during this time has pointed to the concept of biological integrity as an overarching goal of lake management, strongly related to the reproductive status and abundance of fish in high mountain lakes.



Bull trout are native to Washington State waters and are listed as threatened under the Endangered Species Act.

Challenged with the task of synthesizing existing information, the Technical Advisory Committee developed a database that comprehensively describes each of the mountain lakes in the scope of this planning effort. A variety of records and sources were compiled and queried for each of the 91 lakes to describe, among many things, fish stocking history, fish reproduction success, chemical and biological conditions, and which lakes had an inlet or outlet leading to another lake (see appendix E for a complete description of the attributes of the lakes).

After determining the existing conditions of each lake, the Technical Advisory Committee then developed a method to characterize and sort the lakes. Characterizing the lakes provided an organizational tool used to help analyze resource impacts that could occur under each of the action alternatives described in this chapter. It was also a useful tool in gauging how each of the management alternatives met the objectives in taking action, as described in the "Purpose of and Need for Action" chapter.

APPLICATION OF RESEARCH

The 1985 Memorandum of Understanding and 1988 Supplemental Agreement, as well as the 1991 Consent Decree (see the "Purpose of and Need for Action" chapter for a discussion of these three documents and appendix A for copies), called for research that could be used to more fully understand the environmental impacts of fish stocking. This information could then be used to develop future management decisions. The primary technical challenge in preparing this plan/EIS involved applying the large body of available ecological knowledge and theory. This section provides an overview of how research results and ecological concepts were applied to

> develop management alternatives that conserve biological integrity while allowing fish to occur in some lakes
>
> describe the ecosystem functions and human values that could be potentially affected by fishery management actions
>
> evaluate the potential impacts of management alternatives on ecosystem functions and human values

The "Environmental Consequences" chapter provides further details of how research was used to formulate management actions and evaluate their effects. The Technical Advisory Committee for this plan/EIS adopted the following common definition of biological integrity:

> The capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region (Karr and Dudley 1981).

The water quality parameter total Kjeldahl nitrogen, or TKN, is a surrogate measure for lake productivity. See appendix F for a detailed description of TKN.

To relate the purpose of "conserving biological integrity" to mountain lakes fishery management, the Technical Advisory Committee drew upon the principal conclusions of the OSU research, including the ecological effects of nonnative trout are related to the reproductive status and abundance of trout in lakes. The Technical Advisory Committee interpreted this finding to mean that lakes with the lowest degree of biological integrity (or greatest departure from biological integrity or pristine conditions) contained reproducing populations of nonnative trout or char that had achieved high densities. On the other end of the biological integrity spectrum, the Technical Advisory Committee assumed mountain lakes that had never been stocked represented the highest degree of biological integrity. By taking the general concept of biological integrity and defining it in the context of this plan/EIS, this approach allowed the Technical Advisory Committee to formulate a conceptual framework for "conserving biological integrity" by relating how the reproductive status and abundance of nonnative trout influenced the biological integrity of the mountain lakes (see figure 3). This conceptual framework was used to craft management alternatives B and C based on the hypothesis that the biological integrity of mountain lakes could potentially be conserved by managing for nonreproducing trout at low densities in some lakes and managing for fishless conditions in other lakes.

The OSU research recommended that "a prudent and precautionary management strategy would be to maximize protection of all North Cascades Complex lakes with relatively high total Kjeldahl nitrogen (TKN)" (Liss et al. 2002). In other words, the concentration of TKN could be used as one criterion for selecting lakes for stocking and for fish removal. Productive lakes (those with relatively high TKN) should remain fishless to provide productive habitat for native species, particularly amphibians.

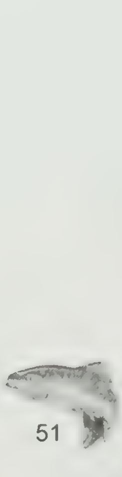
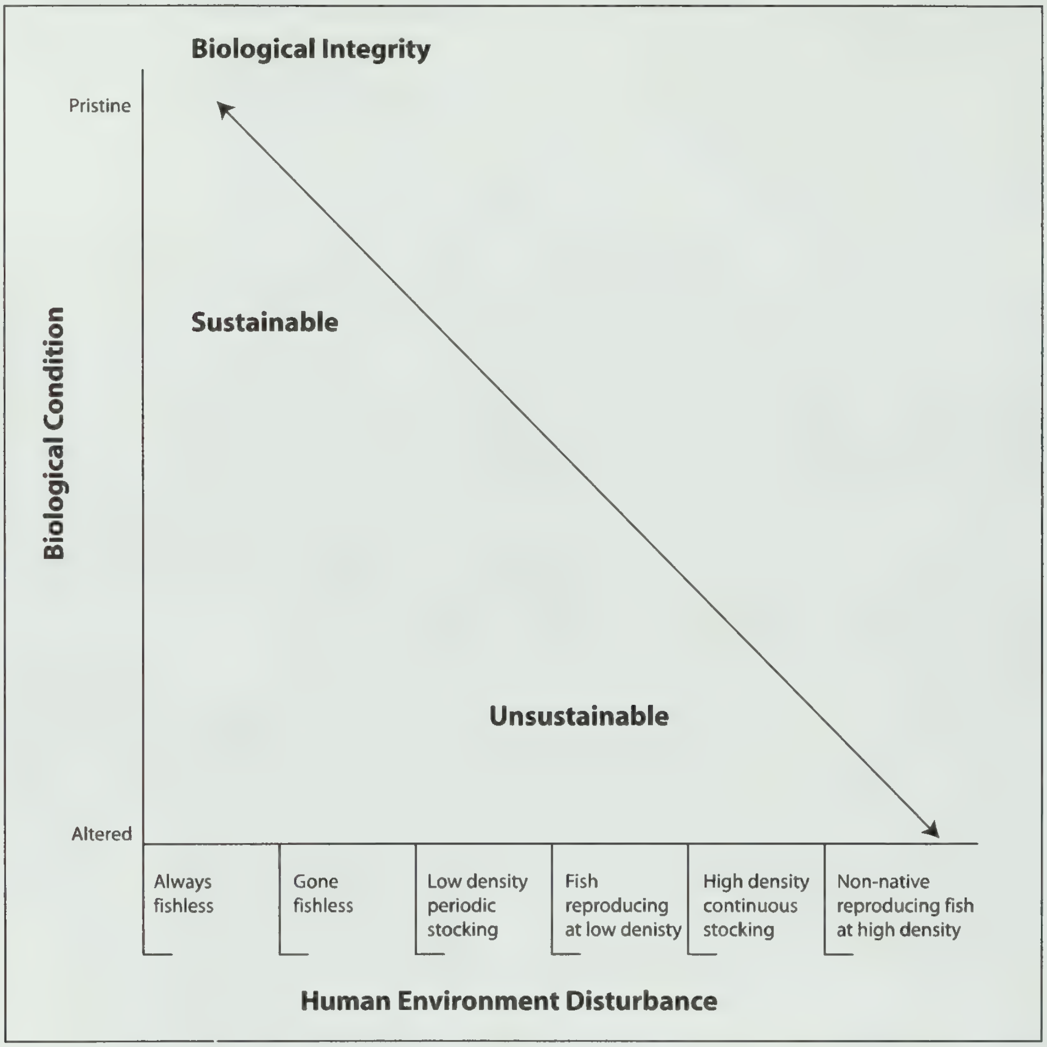


FIGURE 3: MANAGEMENT MODEL FOR CONSERVING BIOLOGICAL INTEGRITY IN MOUNTAIN LAKES


Biological Integrity
Pristine
Sustainable
Biological Condition
Unsustainable
Altered
Always fishless
Gone fishless
Low density periodic stocking
Fish reproducing at low denisty
High density continuous stocking
Non-native reproducing fish at high density
Human Environment Disturbance

Note: This figure illustrates the application of a conceptual biological integrity model (based on Karr 2000) to disturbance associated with various states of nonnative fish presence in naturally fishless mountain lakes (Downen 2004). The model illustrates a theoretical relationship between the reproductive status and abundance of nonnative trout and their impact on the biological condition or integrity of mountain lakes. When considered in the context of fisheries management, lakes that have always been fishless are believed to have the highest degree of biological integrity. In contrast, lakes that have high densities of reproducing trout are believed to have the lowest degree of biological integrity, as demonstrated by the OSU research findings. Alternatives B and C were developed based on the biological integrity model hypothesis that fishery management actions could conserve biological integrity by (a) preventing stocking of currently fishless lakes; (b) removing reproducing populations of fish where feasible; and (c) stocking low densities of nonreproducing fish in select lakes according to the management principles described in table 2. Removal of reproducing fish populations (especially at high densities) from lakes was also proposed as an element common to all action alternatives (WDFW 2003).

The Technical Advisory Committee initially attempted to adopt the OSU research recommendation as a means of selecting lakes to be fishless based on impacts of trout. However, this was abandoned out of concern for (a) making biologically based decisions centered on a threshold concentration of a single water-quality parameter and (b) only protecting one class of ecosystem type rather than maintaining a diversity of fishless ecosystems. Instead, the Technical Advisory Committee considered TKN as part of a suite of physical, chemical, biological, and spatial criteria for determining what lakes could be stocked and what lakes should remain fishless. This more complex decision-making process accommodated the results of other research (for example, impacts on native fish that can occur when nonnative trout migrate downstream from lakes) and aided in the consideration of impacts on native organisms at multiple biological scales (organism, species, community) and spatial scales (within a lake, lake clusters, watersheds).

In contrast to alternatives B and C, alternative D (91 Lakes Would Be Fishless) was crafted to meet the spirit and intent of NPS policies by discontinuing stocking and eventually removing reproducing populations of fish from mountain lakes wherever feasible. This management alternative was not based specifically upon a research finding related to the ecological effects of nonnative fish in North Cascades Complex lakes. Instead, alternative D was developed because it most closely achieved the spirit and intent of NPS policies regarding management of nonnative species. These policies are based upon the wide body of scientific evidence that nonnative species can have broad impacts on ecosystem functions and values. Alternative D also provides a basis for comparing the effects of the no-action alternative (alternative A) and the other action alternatives.

Alternative D emphasizes conservation of biological integrity by establishing a goal of completely removing nonnative fish from lakes in the North Cascades Complex. Researchers and resource managers have attempted to remove trout from mountain lakes in the western United States and Canada, and results have been mixed. These results demonstrate that complete removal may not be achieved in all lakes containing reproducing fish. Nine lakes have been identified where complete removal may not be feasible. Alternative D meets all of the management objectives to a large degree, with the exception of offering a diversity of recreational opportunities, including sport fishing. However, fishing opportunities would continue to be available in the foreseeable future while fish removal activities are completed. In addition, fishing opportunities would still remain in the reservoirs, rivers, and some streams throughout the North Cascades Complex.

Adaptive management incorporates monitoring and research into conservation actions. Specifically, it is the integration of planning, management, and monitoring to test assumptions in order to adapt and learn.

The Technical Advisory Committee recognized that each management alternative was developed with scientific information and data that are provisional and possibly incorrect. In light of this uncertainty, the Technical Advisory Committee included the principle of adaptive management as an element common to all action alternatives. Adaptive management "focuses on management as a learning process or continuous experiment where incorporating the results of previous actions allows managers to remain flexible and adapt to uncertainty" (Grumbine 1994). The Technical Advisory Committee incorporated the principle of adaptive management into each of the management alternatives by developing a lake

monitoring plan (see appendix F) to evaluate management actions and create a mechanism for changing those actions if management goals were not being achieved.

The “Affected Environment” chapter of this plan/EIS describes the resources and values that could potentially be affected by fishery management actions. The OSU research generated a large amount of physical, chemical, and biological baseline data on mountain lakes in the North Cascades Complex. The Technical Advisory Committee used these data, along with information from other research and monitoring efforts by the NPS, WDFW, and Trail Blazers, to build a comprehensive database on mountain lakes in the North Cascades Complex. This database, largely derived from past and ongoing research activities, was used to help understand and describe the resources and values that could be affected by fishery management actions.

The OSU research largely evaluated the ecological effects of nonnative trout on aquatic organisms at the scale of individual lakes. To understand the potential effects of nonnative fish at broader scales, including the potential impacts from downstream dispersal, information from other research and monitoring efforts was also extensively used. In the Stehekin River drainage, for example, ongoing research into hybridization between native westslope cutthroat trout and nonnative rainbow trout was used to evaluate the potential impacts of fishery management actions in the drainage. On the west side of the North Cascades Complex, bull trout research and monitoring data were used in a similar fashion.

In summary, this plan/EIS was initiated upon completion of the OSU research into the ecological effects of nonnative trout because the research provided a critical mass of information. The OSU research contributed greatly to the formation of management alternatives and the impact analysis process; however, the results of many other research efforts were used to craft the management alternatives and evaluate impacts. More thorough descriptions on the role of research are provided in the “Environmental Consequences” chapter. The use of research results, including widely accepted ecological principles, helped to achieve the stated objective of ensuring that decisions would be made in accordance with the best available science.

DEVELOPMENT OF MANAGEMENT ACTIONS FOR ALTERNATIVES B AND C

Various decision-making criteria emerged during the process of reviewing research. These refined criteria (ecological risk factors) are described in table 1. The Technical Advisory Committee reviewed the conditions of each lake and applied the factors in table 1. Then, the principles in table 2 were used to determine the management action for each lake.

Table 3 shows how the ecological risk factors and principles were assigned to each lake. A more detailed discussion of how these principles would be applied to determine final management actions for each lake can be found in the descriptions of each alternative later in this chapter.

TABLE 1: ECOLOGICAL RISK FACTORS FOR NEW MANAGEMENT FRAMEWORK

Fishless conditions currently present	Is the lake currently fishless? This suggests that protecting currently fishless (though historically stocked) lakes is biologically beneficial because the lakes are slowly reverting to pre-stocking conditions, and there is no compelling reason to alter that process.
Unique lake features or circumstances	Does the lake posses any unique features or circumstances that would favor fishless conditions, such as **Geographic Isolation**: Is the lake isolated from other water bodies that serve as a refuge or breeding habitat for the long-toed salamander? Isolated lakes may be very important for protecting isolated populations of salamanders, especially if the surrounding habitat consists of shallow ponds or wetlands that could dry up or be otherwise impacted by random natural events. This risk factor acknowledges that isolated populations of native species, such as long-toed salamanders that are slow to disperse, must be sufficiently distributed across the landscape to ensure their long-term sustainability. Consideration of geographic isolation helps to ensure that metapopulations of such amphibian species are adequately protected at the broadest spatial scales. **Species of Conservation Concern**: Do rare or unique species (such as the blind amphipod) reside in the lake? Blind amphipods are found in at least two park lakes and may be in other lakes that have not been sampled. Amphipods are a type of macroinvertebrate that can be an important food source for fish and could be inadvertently lost due to predation. Should other organisms of conservation concern be found through monitoring, fishery management actions would be adjusted to prevent harm. Could species of special concern (such as the bull trout) be affected by the presence of nonnative fish in lakes? Native fish species that reside in streams could potentially be affected through hybridization and competition by nonnative fish escaping from lakes into streams. **Under-represented Lake Type**: Is the lake large and deep or geologically unique? These lakes are often candidates for stocking, and most of the large lakes in the park have traditionally been stocked. Therefore, it is necessary to establish a representative number of large, deep lakes as fishless in order to protect the unique aquatic organisms that may prefer this type of lake.
Capacity to serve as suitable habitat for, and within the range of, long-toed salamanders	Does the lake have the appropriate physical habitat and biological productivity to produce and maintain source populations of long-toed salamanders? Long-toed salamanders are biological indicators of an unsustainable fish density because they are particularly sensitive to fish predation. Since the long-toed salamander is more sensitive than most other amphibians to fish predation, protecting habitat for long-toed salamanders helps to prevent elimination of in-lake populations and protect overall health of amphibians in the North Cascades Complex. This criterion recognizes that lakes in the North Cascades Complex vary widely in habitat quality for salamanders. The physical, chemical, and biological characteristics of lakes make some more suitable than others for nurturing genetically sustainable populations of long-toed salamanders. Populations of long-toed salamanders in lakes that provide high-quality habitat can withstand the impacts of disturbance (such as drought) and, presumably, recolonize the surrounding watershed following disturbance. Long-toed salamanders are only able to reproduce in large numbers in lakes that provide high-quality habitat. In addition to reproduction, their offspring must be able to survive in numbers that are sufficient for ensuring long-term genetic diversity. To meet this criterion, the lake must also be located in what is considered the geographic range of the long-toed salamander.
Shared lake conditions exist between the long-toed salamander and fish	Does evidence suggest that a lake can maintain fish populations while allowing salamanders to coexist? Situations have been observed in lakes where both fish and salamander populations exist. It is assumed that these lakes possess special features such as shallow habitat, large amounts of woody debris, or a complex shoreline configuration that protects salamanders from fish predation.
Presence of high density of reproducing fish	Have stocked fish reproduced and overpopulated the lake? High densities of fish have the ability to deplete their food base and cause measurable declines and, in some cases, disappearance of native aquatic species. This factor seeks to identify lakes that should be considered and prioritized for fish removal.
Macroinvertebrate populations are suppressed	Are macroinvertebrate populations within a lake suppressed? Certain taxa of macroinvertebrates are sensitive to fish predation. Macroinvertebrates, like amphibians, are good indicators of ecosystem health and the effect fish have on the ecosystem. Currently, limited data are available for this criterion, but it is an important factor.
Lake grouping	Is the lake a part of a unique grouping where at least one of the lakes should be established as fishless? In certain areas, several lakes are located in relatively close proximity (e.g., Hozomeen, Willow, and Ridley lakes). Management actions for these lakes need to be considered collectively. This criterion suggests that at least one lake in a grouping of lakes in a unique geographical location or physical circumstance should be maintained as fishless in order for natural conditions to exist. This concept allows for a wide diversity of lake types to be represented in a fishless state. Lakes that contain fish and are in relatively close proximity to one another were considered collectively, and management actions were tailored to minimize the potential impacts to metapopulations of salamanders in these lake groupings.
Lack of Information	Data is lacking for some lakes. This factor acknowledges uncertainty and the need for gathering additional information before taking management actions.

TABLE 2: PRINCIPLES FOR MANAGING THE MOUNTAIN LAKES FISHERY TO CONSERVE BIOLOGICAL INTEGRITY

1. A prudent and precautionary management strategy should protect all lakes that are currently fishless. A lake that is fishless today would remain fishless in the future.
2. Reproducing populations of fish that have achieved high densities would be removed from all lakes where feasible. Following removal, the biological conditions of the lakes would be monitored for recovery. Monitoring results would be used to decide whether or not the lake could be stocked with low densities of nonreproducing fish.
3. Lakes that serve as high-quality breeding and rearing habitat for amphibians and are located within the range of long-toed salamanders, generally would be returned to a fishless condition, or low densities of nonreproducing fish would be allowed if no other criteria applied. However, observations indicate that certain lakes have complex habitat conditions, such as extensive shallow areas and woody debris, which would allow amphibian populations to persist in spite of fish predation or competition. Where a lake has a long history of stocking and salamanders are known to exist sympatrically (together in the same area; for example, Coon Lake), nonreproducing fish would be stocked at low densities.
4. Certain lakes would be managed as fishless due to unique features. These features include the presence of a species of conservation concern; large, deep lakes in fishless conditions (which are underrepresented in the North Cascades Complex); geologically unique lakes; and geographically isolated lakes. Geographically isolated lakes need to remain fishless to protect metapopulations of salamanders. A lake was considered isolated if (1) it was more than 2,000 feet from other permanent water bodies, (2) it was within the range of long-toed salamanders, and (3) there was no evidence that salamanders and fish could survive sympatrically. Lakes that possessed these unique features were considered on a larger landscape scale to determine if fishless conditions were represented among these lake types. A lake that belonged to an underrepresented type in the study area would be returned to a fishless condition.
5. Benthic (bottom dwelling) macroinvertebrate monitoring data (collected through the NPS long-term ecological monitoring program) indicate that certain lakes have suppressed populations of macroinvertebrates. A lake with suppressed populations of macroinvertebrates would become fishless or would be evaluated further before determining final management action.
6. In closely grouped lakes, fishless conditions in at least one lake would be maintained to provide fishless habitat for aquatic organisms in the localized area.
7. Where key information for a given lake was lacking for this stage of planning, the lake would be evaluated before management actions would be recommended.
8. Lakes that do not possess any of the identified risk factors (decision criteria) would be considered for stocking to maintain fish densities commensurate with the protection of biological integrity.

TABLE 3: DECISION CRITERIA FOR MANAGEMENT ACTIONS

Lake Name and NPS Lake Code	Ecological Risk Factor								Principle for Determining Management Action[b]
	Lack of Data[a]	Presence of reproducing fish (x = at high densities)	Fishless conditions currently present in lake	Capacity to serve as high-quality breeding and rearing habitat for amphibians and with in the range of long-toed salamanders	Presence of long-toed salamanders	The lake possesses unique features or circumstances that would favor fishless conditions (isolated lake, species of conservation concern present, large/deep lakes, geologically unique lakes)	The lake is part of a lake grouping where fishless conditions should be represented	Macroinvertebrate populations known to be suppressed	
Azure MP-09-01			X						Principle 1 applies
Battalion MLY-02-01	X	X		X					Principle 2 applies; principle 3 may apply
Bear MC-12-1		X					F		Principles 2 and 8 apply
Berdeen M-08-01		X					A		Principles 2 and 8 apply
Berdeen, Lower M-07-01		X		X	X		A		Principles 2 and 3 apply
Berdeen, Upper M-09-01		X					A		Principles 2 and 6 apply
Blum (Largest/ Middle, No. 3) M-11-01	X	X		X			B		Principle 2 applies; principle 3 may apply
Blum (Lower/ West, No. 4) LS-07-01		X		X			B		Principles 2 and 6 apply
Blum (Small/ North, No. 2) MC-01-01			X	X	X		B		Principle 1 applies
Blum (Vista/Northwest, No. 1) MC-02-01			X	X	X		B		Principle 1 applies
Bouck, Lower DD-04-01		X					C		Principles 2 and 8 apply
Bouck, Upper DD-05-01				X	X		C		Principle 6 applies
Bowan MR-12-01				X	X	X			Principle 4 applies
Coon MM-10-01				X	X				Principle 3 applies

TABLE 3: DECISION CRITERIA FOR MANAGEMENT ACTIONS (CONTINUED)

Lake Name and NPS Lake Code	Ecological Risk Factor								Principle for Determining Management Action[b]
	Lack of Data[a]	Presence of reproducing fish (x = at high densities)	Fishless conditions currently present in lake	Capacity to serve as high-quality breeding and rearing habitat for amphibians and with in the range of long-toed salamanders	Presence of long-toed salamanders	The lake possesses unique features or circumstances that would favor fishless conditions (isolated lake, species of conservation concern present, large/deep lakes, geologically unique lakes)	The lake is part of a lake grouping where fishless conditions should be represented	Macroinvertebrate populations known to be suppressed	
Copper[c] MC-06-01	X			X	X		F		Principle 3 applies; principle 1 may apply
Dagger MR-04-01	X	X		X					Principle 2 applies; principle 3 may apply
Dee Dee / Tamarack, Lower MR-15-02				X			G		Principle 6 applies
Dee Dee, Upper MR-15-01	X	X		X			G		Principle 6 applies
Despair, Lower M-14-01			X						Principle 1 applies
Despair, Upper M-13-01			X						Principle 1 applies
Diobsud No. 1, separate, not connected LS-01-01		X		X	X		M		Principles 2 and 6 apply
Diobsud No. 2, Lower LS-02-01	X	X		X	X		M		Principles 2 and 3 apply
Diobsud No. 3, Upper LS-03-01				X	X	X		X	Principles 4 and 5 apply
Doubtful CP-01-01		X							Principles 2 and 8 apply
Doug's Tarn M-21-01		X							Principles 2 and 8 apply
East, Lower MC-14-02			X						Principle 1 applies
East, Upper MC-14-01			X			X			Principle 1 applies
Firn MP-02-01	X								Principle 8 applies

TABLE 3: DECISION CRITERIA FOR MANAGEMENT ACTIONS (CONTINUED)

Lake Name and NPS Lake Code	Ecological Risk Factor								Principle for Determining Management Action[b]
	Lack of Data[a]	Presence of reproducing fish (x = at high densities)	Fishless conditions currently present in lake	Capacity to serve as high-quality breeding and rearing habitat for amphibians and with in the range of long-toed salamanders	Presence of long-toed salamanders	The lake possesses unique features or circumstances that would favor fishless conditions (isolated lake, species of conservation concern present, large/deep lakes, geologically unique lakes)	The lake is part of a lake grouping where fishless conditions should be represented	Macroinvertebrate populations known to be suppressed	
Green M-04-01	X	X		X					Principle 2 applies; principle 3 may apply
Green Bench LS-04-01			X						Principle 1 applies
Hanging MC-08-01		X		X		X			Principles 2 and 4 apply
Hidden SB-01-01							H		Principle 8 applies
Hidden Lake Tarn EP-14-01							H		Principle 6 applies
Hi-Yu M-01-01	X			X	X	X		X	Principles 4 and 5 apply
Hozomeen HM-02-01		X				X	E		Principles 2 and 4 apply
Ipsoot LS-06-01	X			X	X				Principle 3 applies
Jeanita DD-01-01	X			X	X				Principle 3 applies
Kettling MR-05-01		X		X	X	X			Principles 2 and 4 apply
Kwahnesum MC-07-01				X	X	X			Principle 4 applies
McAlester MR-10-01	X	X		X	X				Principle 3 applies; principle 2 may apply
Middle, Lower MC-16-02			X						Principle 1 applies
Middle, Upper MC-16-01			X						Principle 1 applies
Monogram M-23-01		X		X	X		I		Principles 2 and 3 apply

TABLE 3: DECISION CRITERIA FOR MANAGEMENT ACTIONS (CONTINUED)

Lake Name and NPS Lake Code	Ecological Risk Factor								Principle for Determining Management Action[b]
	Lack of Data[a]	Presence of reproducing fish (x = at high densities)	Fishless conditions currently present in lake	Capacity to serve as high-quality breeding and rearing habitat for amphibians and with in the range of long-toed salamanders	Presence of long-toed salamanders	The lake possesses unique features or circumstances that would favor fishless conditions (isolated lake, species of conservation concern present, large/deep lakes, geologically unique lakes)	The lake is part of a lake grouping where fishless conditions should be represented	Macroinvertebrate populations known to be suppressed	
Monogram Tarn M-23-11				X		X	I		Principle 4 applies
Nert M-05-01				X	X	X			Principle 4 applies
Noisy Creek, Upper LS-14-01			X						Principle 1 applies
No Name PM-01-01									Principle 8 applies
Panther Potholes, Lower RD-05-02									Principle 3 applies
Panther Potholes, Upper RD-05-01			X						Principle 1 applies
Pegasus EP-10-01			X						Principle 1 applies
Pond SE of Kettling Lakes MR-09-01				X	X				Principle 3 applies
Quill, Lower M-24-02	X			X			J		Principle 2 applies; principle 3 may apply
Quill, Upper M-24-01	X			X			J		Principles 3 and 6 apply
Rainbow MR-14-01		X		X	X		D		Principles 2 and 3 apply
Rainbow, Upper (North) MR-13-01			X	X	X		D		Principle 1 applies
Rainbow, Upper (South) MR-13-02				X	X		D		Principle 6 applies
Rainbow, Upper (West) MM-11-01							D		Principle 6 applies
Redoubt MC-11-01			X			X			Principle 1 applies

TABLE 3: DECISION CRITERIA FOR MANAGEMENT ACTIONS (CONTINUED)

Lake Name and NPS Lake Code	Ecological Risk Factor								Principle for Determining Management Action[b]
	Lack of Data[a]	Presence of reproducing fish (x = at high densities)	Fishless conditions currently present in lake	Capacity to serve as high-quality breeding and rearing habitat for amphibians and with in the range of long-toed salamanders	Presence of long-toed salamanders	The lake possesses unique features or circumstances that would favor fishless conditions (isolated lake, species of conservation concern present, large/deep lakes, geologically unique lakes)	The lake is part of a lake grouping where fishless conditions should be represented	Macroinvertebrate populations known to be suppressed	
Reveille, Lower MC-21-02			X						Principle 1 applies
Reveille, Upper MC-21-01			X						Principle 1 applies
Ridley HM-03-01							E		Principle 8 applies
Sky EP-13-01			X						Principle 1 applies
Skymo PM-03-01		X		X					Principle 3 applies
Sourdough PM-12-01	X	X		X					Principle 2 applies; principle 3 may apply
Sourpuss ML-01-01			X						Principle 1 applies
Stiletto MR-01-01	X							X	Principles 4 and 5 apply
Stout EP-09-02	X								Principle 8 applies
Stout, Lower EP-09-01	X								Principle 8 applies
Sweet Pea ML-02-01									Principle 8 applies
Talus Tarn M-06-01			X	X	X				Principle 1 applies
Tapto, Lower MC-17-03			X						Principle 1 applies
Tapto, Middle MC-17-02			X						Principle 1 applies
Tapto, Upper MC-17-01			X						Principle 1 applies

TABLE 3: DECISION CRITERIA FOR MANAGEMENT ACTIONS (CONTINUED)

Lake Name and NPS Lake Code	Ecological Risk Factor								Principle for Determining Management Action[b]
	Lack of Data[a]	Presence of reproducing fish (x = at high densities)	Fishless conditions currently present in lake	Capacity to serve as high-quality breeding and rearing habitat for amphibians and with in the range of long-toed salamanders	Presence of long-toed salamanders	The lake possesses unique features or circumstances that would favor fishless conditions (isolated lake, species of conservation concern present, large/deep lakes, geologically unique lakes)	The lake is part of a lake grouping where fishless conditions should be represented	Macroinvertebrate populations known to be suppressed	
Tapto, West MC-17-04			X						Principle 1 applies
Thornton, Lower M-20-01				X	X				Principle 3 applies
Thornton, Middle M-19-01									Principle 8 applies
Thunder RD-02-01			X						Principle 1 applies
Tiny MC-15-01			X						Principle 1 applies
Torment ML-03-01						X		X	Principles 4 and 5 apply
Trapper GM-01-01	X								Principle 8 applies
Triplet, Lower SM-02-01		X		X			K		Principles 2 and 6 apply
Triplet, Upper SM-02-02		X					K		Principles 2 and 6 apply
Triumph M-17-01				X	X				Principle 3 applies
Unnamed/ FP-01-01			X						Principle 1 applies
Unnamed MR-11-01				X	X				Principle 3 applies
Unnamed MR-16-01	X			X	X				Principle 3 applies
Vulcan ML-04-01			X						Principle 1 applies
Wilcox/Lillie, Upper EP-06-01		X					L		Principles 2 and 6 apply

TABLE 3: DECISION CRITERIA FOR MANAGEMENT ACTIONS (CONTINUED)

Lake Name and NPS Lake Code	Ecological Risk Factor								Principle for Determining Management Action[b]
	Lack of Data[a]	Presence of reproducing fish (x = at high densities)	Fishless conditions currently present in lake	Capacity to serve as high-quality breeding and rearing habitat for amphibians and with in the range of long-toed salamanders	Presence of long-toed salamanders	The lake possesses unique features or circumstances that would favor fishless conditions (isolated lake, species of conservation concern present, large/deep lakes, geologically unique lakes)	The lake is part of a lake grouping where fishless conditions should be represented	Macroinvertebrate populations known to be suppressed	
Wilcox/Sandie, Lower EP-05-01		X					L		Principles 2 and 8 apply
Wild MC-27-01			X						Principle 1 applies
Willow HM-04-01							E		Principle 8 applies

Lake Groupings

A. Berdeen; Berdeen, Lower; Berdeen, Upper

B. Blum (Largest/Middle, No. 3); Blum (Lower/West, No. 4); Blum (Small/North, No. 2); Blum (Vista/Northwest, No. 1)

C. Bouck, Lower; Bouck, Upper

D. Rainbow; Rainbow, Upper (North); Rainbow, Upper (South); Rainbow, Upper (West)

E. Hozomeen; Ridley; Willow

F. Bear; Copper

G. Dee Dee, Upper; Dee Dee / Tamarack, Lower

H. Hidden; Hidden Lake Tarn

I. Monogram; Monogram Tarn

J. Quill, Lower; Quill, Upper

K. Triplet, Lower; Triplet, Upper

L. Wilcox/Lillie, Upper; Wilcox/Sandie, Lower

M. Diobsud No. 1, separate, not connected; Diobsud No. 2, Lower

Notes:

a. "Lack of Data" indicates lakes where data would have to be obtained prior to taking management actions.

b. Refer to table 2 in this "Alternatives" chapter for descriptions of the principles.

c. In August 2004, a large fish kill was observed in Copper Lake, possibly due to disease. Further surveys are needed to confirm that the lake is fishless.

MANAGEMENT ACTIONS

Standard management actions were developed and applied to a differing subset of lakes in alternatives B and C according to the principles described in table 2. Where data are missing, the management action includes an evaluation element that would require more information to be collected prior to determining the management action. The standardized adaptive management actions shown in table 4 emerged from this process.

A lake-by-lake application of the management actions is in table 5. These standard management actions may not be rigidly adhered to indefinitely. All management actions would be applied according to the principles of adaptive management. Table 6 lists the 62 lakes in the North Cascades Complex managed by the WDFW that are known to contain fish; the reproducing fish species currently present in 35 of these lakes; and the species, strains, densities, and stocking cycles of fish to be stocked under the proposed new management frameworks for alternatives B and C. Stocking information for alternative A is also shown in this table.

A summary of the adaptive management concept can be found in this chapter under “Elements Common to All Action Alternatives” in the “Adaptive Management” section.

TABLE 4: DESCRIPTION OF MANAGEMENT ACTIONS

This table presents a standard set of fishery management actions for implementation under alternatives B and C. Note that management actions under alternative A would not change from current management, and management actions under alternative D only involve stopping stocking and removing all fish. The standard management actions in this table are broken down into classes 1-4, based on the Technical Advisory Committee's current understanding of the presence, reproductive status, and density of fish in the lakes. These standard management actions would require periodic monitoring and evaluation to facilitate adaptive management.	
For a lake that is currently fishless:	
1	The lake would remain fishless.
For a lake with high densities of reproducing fish, apply one of the following management actions:	
2A	Remove all reproducing fish. Monitor the recovery of native organisms and keep the lake fishless.
2B	Remove all reproducing fish. Monitor lake conditions and use the results to determine whether or not to restock the lake with nonreproducing fish. If the lake is restocked and monitoring results indicate fish are causing major adverse impacts, then fish densities would be reduced by changing stocking densities, stocking cycles, or the species of stocked fish. If these management changes do not work, then discontinue stocking (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
2C	Remove all reproducing fish. Implement a resting period (that is, keep the lake fishless for a period of time) to foster recovery of native organisms. The duration of the resting period will be determined on a lake-by-lake basis based upon monitoring results. If monitoring results indicate favorable recovery of native organisms, then restock the lake with low densities of nonreproducing fish and monitor lake conditions. If monitoring results indicate fish are causing major adverse impacts, then reduce stocking densities, stocking cycles, or the species of stocked fish. If these management changes do not work, then discontinue stocking (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
For a lake with low densities of reproducing fish, apply one of the following management actions:	
3A	Remove all reproducing fish. Monitor the recovery of native organisms, and keep the lake fishless.
3B	Evaluate the reproductive status of fish and the status of indicator taxa. If fish density is high enough that impacts on indicator taxa may be major, apply prescription 2A, 2B, or 2C. If fish densities and impacts to indicator taxa are low, maintain the low fish densities. If monitoring data indicate fish are causing major adverse impacts, then completely remove fish (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
3C	For lakes with extremely low densities of fish, augment the population with supplemental stocking and monitor indicator taxa. If monitoring results indicate fish are causing major adverse impacts, then stop stocking and remove all fish (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
For a lake that has been stocked and does not contain a reproducing population of fish, apply one of the following management actions:	
4A	Discontinue stocking. Monitor the recovery of native organisms.
4B	Lack of data for decision-making. Discontinue stocking and monitor lake conditions. If the lake is restocked and monitoring results indicate fish are causing major adverse impacts, then discontinue stocking (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).
4C	Continue stocking with low densities of fish expected not to reproduce in the lake. If monitoring results indicate fish are causing major adverse impacts, then reduce stocking densities, stocking cycles, or the species of stocked fish. If these management changes do not work, then discontinue stocking (see "Appendix F: Proposed Monitoring Plan for the Mountain Lakes Fishery Management Plan" for more information on adaptive management).

TABLE 5: MANAGEMENT ACTIONS FOR EACH OF THE 91 LAKES

Note: The shaded rows indicate the 22 lakes that are in Ross Lake and Lake Chelan National Recreation Areas; the other 69 lakes are in the national park portion of the North Cascades Complex.

Lake Name	NPS Lake Code	Current Condition of Lake (as represented under alternative A)	Management Action		
			Alternative B	Alternative C	Alternative D
Azure	MP-09-01	Fishless	1	1	1
Battalion	MLY-02-01	High density reproducing fish	2B	2B	2A
Bear	MC-12-1	High density reproducing fish	2C	2A	2A
Berdeen	M-08-01	High density reproducing fish	2C	2A	2A
Berdeen, Lower	M-07-01	High density reproducing fish	2A	2A	2A
Berdeen, Upper	M-09-01	High density reproducing fish	2A	2A	2A
Blum (Largest/Middle, No. 3)	M-11-01	High density reproducing fish	2B	2A	2A
Blum (Lower/West, No. 4)	LS-07-01	High density reproducing fish	2C	2A	2A
Blum (Small/North, No. 2)	MC-01-01	Fishless	1	1	1
Blum (Vista/Northwest, No. 1)	MC-02-01	Fishless	1	1	1
Bouck, Lower	DD-04-01	High density reproducing fish	2C	2C	2A
Bouck, Upper	DD-05-01	Stocked with nonreproducing fish	4A	4A	4A
Bowan	MR-12-01	Stocked with nonreproducing fish	4A	4A	4A
Coon	MM-10-01	Stocked with nonreproducing fish	4C	4C	4A
Copper[a]	MC-06-01	Stocked with nonreproducing fish	4B	4A	4A
Dagger	MR-04-01	High density reproducing fish	2B	2A	2A
Dee Dee, Upper	MR-15-01	High density reproducing fish	2B	2A	2A
Dee Dee/Tamarack, Lower	MR-15-02	Stocked with nonreproducing fish	4A	4A	4A
Despair, Lower	M-14-01	Fishless	1	1	1
Despair, Upper	M-13-01	Fishless	1	1	1
Diobsud No. 1	LS-01-01	High density reproducing fish	2A	2A	2A
Diobsud No. 2, Lower	LS-02-01	High density reproducing fish	2B	2A	2A
Diobsud No. 3, Upper	LS-03-01	Stocked with nonreproducing fish	4A	4A	4A
Doubtful	CP-01-01	High density reproducing fish	2C	2A	2A
Doug's Tarn	M-21-01	High density reproducing fish	2C	2A	2A
East, Lower	MC-14-02	Fishless	1	1	1
East, Upper	MC-14-01	Fishless	1	1	1
Firn	MP-02-01	Low density reproducing fish	3B	3A	3A
Green	M-04-01	High density reproducing fish	2B	2A	2A
Green Bench	LS-04-01	Fishless	1	1	1
Hanging	MC-08-01	High density reproducing fish	2A[b]	2A[b]	2A[b]
Hidden	SB-01-01	Low density reproducing fish	3C	3A	3A
Hidden Lake Tarn	EP-14-01	Stocked with nonreproducing fish	4A	4A	4A
Hi-Yu	M-01-01	Stocked with nonreproducing fish	4B	4A	4A
Hozomeen	HM-02-01	High density reproducing fish	2A	2A	2A
Ipsoot	LS-06-01	Low density reproducing fish	3B	3A	3A
Jeanita	DD-01-01	Low density reproducing fish	3B	3A	3A
Kettling	MR-05-01	High density reproducing fish	2A	2A	2A
Kwahnesum	MC-07-01	Stocked with nonreproducing fish	4A	4A	4A
McAlester	MR-10-01	High density reproducing fish	2B	2B	2A
Middle, Lower	MC-16-02	Fishless	1	1	1
Middle, Upper	MC-16-01	Fishless	1	1	1
Monogram	M-23-01	High density reproducing fish	2C	2A	2A
Monogram Tarn	M-23-11	Stocked with nonreproducing fish	4A	4A	4A
Nert	M-05-01	Stocked with nonreproducing fish	4A	4A	4A

TABLE 5: MANAGEMENT ACTIONS FOR EACH OF THE 91 LAKES (CONTINUED)

Lake Name	NPS Lake Code	Current Condition of Lake (as represented under alternative A)	Management Action		
			Alternative B	Alternative C	Alternative D
Noisy Creek, Upper	LS-14-01	Fishless	1	1	1
No Name	PM-01-01	Stocked with nonreproducing fish	4C	4A	4A
Panther Potholes, Lower	RD-05-02	Stocked with nonreproducing fish	4A	4A	4A
Panther Potholes, Upper	RD-05-01	Fishless	1	1	1
Pegasus	EP-10-01	Fishless	1	1	1
Pond SE of Kettling Lakes	MR-09-01	Stocked with nonreproducing fish	4C	4C	4A
Quill, Lower	M-24-02	Stocked with nonreproducing fish	4B	4A	4A
Quill, Upper	M-24-01	Stocked with nonreproducing fish	4B	4A	4A
Rainbow	MR-14-01	High density reproducing fish	2C	2C	2A
Rainbow, Upper (North)	MR-13-01	Fishless	1	1	1
Rainbow, Upper (South)	MR-13-02	Stocked with nonreproducing fish	4A	4A	4A
Rainbow, Upper (West)	MM-11-01	Stocked with nonreproducing fish	4A	4A	4A
Redoubt	MC-11-01	Fishless	1	1	1
Reveille, Lower	MC-21-02	Fishless	1	1	1
Reveille, Upper	MC-21-01	Fishless	1	1	1
Ridley	HM-03-01	Stocked with nonreproducing fish	4C	4C	4A
Sky	EP-13-01	Fishless	1	1	1
Skymo	PM-03-01	High density reproducing fish	2C	2A	2A
Sourdough	PM-12-01	High density reproducing fish	2B	2A	2A
Sourpuss	ML-01-01	Fishless	1	1	1
Stiletto	MR-01-01	Stocked with nonreproducing fish	4B	4A	4A
Stout	EP-09-02	Low density reproducing fish	3B	3A	3A
Stout, Lower	EP-09-01	Low density reproducing fish	3B	3A	3A
Sweet Pea	ML-02-01	Stocked with nonreproducing fish	4C	4A	4A
Talus Tarn	M-06-01	Fishless	1	1	1
Tapto, Lower	MC-17-03	Fishless	1	1	1
Tapto, Middle	MC-17-02	Fishless	1	1	1
Tapto, Upper	MC-17-01	Fishless	1	1	1
Tapto, West	MC-17-04	Fishless	1	1	1
Thornton, Lower	M-20-01	Low density reproducing fish	3C	3A	3A
Thornton, Middle	M-19-01	Stocked with nonreproducing fish	4C	4A	4A
Thunder	RD-02-01	Fishless	1	1	1
Tiny	MC-15-01	Fishless	1	1	1
Torment	ML-03-01	Stocked with nonreproducing fish	4A	4A	4A
Trapper	GM-01-01	Low density reproducing fish	3B	3A	3A
Triplet, Lower	SM-02-01	High density reproducing fish	2C	2C	2A
Triplet, Upper	SM-02-02	High density reproducing fish	2A	2A	2A
Triumph	M-17-01	Stocked with nonreproducing fish	4C	4A	4A
Unnamed	FP-01-01	Fishless	1	1	1
Unnamed	MR-11-01	Stocked with nonreproducing fish	4C	4C	4A
Unnamed	MR-16-01	Low density reproducing fish	3B	3B	3A
Vulcan	ML-04-01	Fishless	1	1	1
Wilcox/Lillie, Upper	EP-06-01	High density reproducing fish	2A	2A	2A
Wilcox/Sandie, Lower	EP-05-01	High density reproducing fish	2C	2A	2A
Wild	MC-27-01	Fishless	1	1	1
Willow	HM-04-01	Stocked with nonreproducing fish	4C	4C	4A

Notes:

a. In August 2004, a large fish kill was observed in Copper Lake, possibly due to disease. Further surveys are needed to confirm that the lake is fishless.

b. Remove all reproducing fish pending agreement with British Columbia.

TABLE 6: STATUS OF FISH REPRODUCTION AND CYCLE, STOCKING DENSITY, AND SPECIES OF FISH STOCKED COMPARISON OF ALTERNATIVES A, B, AND C

This plan/EIS is based on adaptive management principles. The cycle, density, and species stocked may change in the future based on monitoring in order to better protect biological resources. The numbers represented in the table below illustrate the estimated stocking cycle, stocking density, and species of fish to be stocked in the future. Any species of fish stocked in the future would be nonreproducing. Proposed stocking density and rotation are based on current lake management. See appendix E for a complete description of the attributes of each lake.

Lake Name	NPS Lake Code	Reproducing Fish Species/Strains			Fish Species/Strains Used for Stocking			Initial Stocking Density (fry/acre)			Frequency of stocking rotation for lakes stocked under Alternatives A, B, and C (x-year cycle)
		Alternative			Alternative			Alternative			
		A	B	C	A	B	C	A	B	C	
Battalion	MLY-02-01	OM	OM	—	OM(MW)	Need data[a] OM(MW)	Need data OM(MW)	50	50	50	1
Bear	MC-12-1	OCL(TL)	—	—	—	OM(MW)	—	—	60	—	4
Berdeen	M-08-01	OCL(TL)	—	—	OM(MW)	OM(MW)	—	50	50	—	5
Berdeen, Lower	M-07-01	OCL(TL)	—	—	—	—	—	—	—	—	—
Berdeen, Upper	M-09-01	OCL(TL)	—	—	—	—	—	—	—	—	—
Blum (Largest/ Middle, No. 3)	M-11-01	OM	—	—	OM(MW)	—	—	50	60	—	4
Blum (Lower/ West, No. 4)	LS-07-01	SF	—	—	—	OM(MW)	—	—	60	—	4
Bouck, Lower	DD-04-01	OCL	—	—		OM(MW)	OM(MW)	—	60	60	4
Bouck, Upper	DD-05-01	—	—	—	OMA	—	—	60	—	—	4
Bowan	MR-12-01	—	—	—	OM(MW)	—	—	125	—	—	6
Coon	MM-10-01	—	—	—	OCL(TL)	OCL(TL)	OCL(TL)	90	90	90	5
Copper[b]	MC-06-01	—	—	—	OM(MW), OCC	Need data OM(MW)	—	65	65	—	4
Dagger	MR-04-01	OC	OC	OC	—	—	—	—	—	—	—
Dee Dee, Upper	MR-15-01	—	—	—	OM(MW)	Need data OM(MW)	Need data, OM(MW)	50	50	50	10
Dee Dee/ Tamarack, Lower	MR-15-02	—	—	—	OM(MW)	OM(MW)	OM(MW)	50	50	50	10
Diobsud No. 1	LS-01-01	OCL(TL)	—	—	—	—	—	—	—	—	—
Diobsud No. 2, Lower	LS-02-01	OCL(TL)	—	—	OM(MW)	OM(MW)	—	70	70	—	5

Table 6: Status of Fish Reproduction and Cycle, Stocking Density, and Species of Fish Stocked Comparison of Alternatives A, B, and C (continued)

Lake Name	NPS Lake Code	Reproducing Fish Species/Strains			Fish Species/Strains Used for Stocking			Initial Stocking Density (fry/acre)			Frequency of stocking rotation for lakes stocked under Alternatives A, B, and C (x-year cycle)
		Alternative			Alternative			Alternative			
		A	B	C	A	B	C	A	B	C	
Diobsud No. 3, Upper	LS-03-01	—	—	—	OM(MW)	OM(MW)	—	80	80	—	4
Doubtful	CP-01-01	OC, OM, OmxOC	—	—	—	OM(MW)	—	—	60	—	4
Doug's Tarn	M-21-01	OC	—	—	—	OM(MW)	—	—	60	—	4
Firn	MP-02-01	OCL(TL)	OCL	—	OM(MW)	Need data OM(MW)	—	50	50	—	5
Green	M-04-01	OCL(TL), OM, OCLxOM	—	—	—	Need data, OM(MW)	—	—	60	—	4
Hanging	MC-08-01	OM	—	—	—	—	—	—	60	—	4
Hidden	SB-01-01	OM(MW)	OM(MW)	—	OM(MW), OMA	OM(MW), OMA	—	20, 40	20, 40	—	4
Hidden Lake Tarn	EP-14-01	—	—	—	OM(MW)	—	—	40	—	—	6
Hi-Yu	M-01-01	—	—	—	OM(MW)	Need data OM(MW)	—	100	100	—	4
Hozomeen	HM-02-01	SF	—	—	—	—	—	—	—	—	—
Ipsoot	LS-06-01	OCB	OCB	—	—	—	—	—	—	—	—
Jeanita	DD-01-01	OMA	OMA	—	—	—	—	75	—	—	—
Kettling	MR-05-01	OC, OM, OMxOC	—	—	—	—	—	—	—	—	—
Kwahnesum	MC-07-01	—	—	—	OM (MW)	OM(MW)	—	100	100	—	5
McAlester	MR-10-01	OCL(TL)	OCL(TL)	OCL(TL)	—	—	—	—	—	—	—
Monogram	M-23-01	OCL(TL)	—	—	OM(MW)	OM(MW)	—	70	70	—	5
Monogram Tarn	M-23-11	—	—	—	OCL(TL)	—	—	No data	—	—	No Data
Nert	M-05-01	—	—	—	OM(MW)	—	—	50	—	—	4
No Name	PM-01-01	—	—	—	OM(MW)	OM(MW)	—	70	70	—	4
Panther Potholes (Lower)	RD-05-02	—	—	—	OCC	—	—	100	—	—	4

Table 6: Status of Fish Reproduction and Cycle, Stocking Density, and Species of Fish Stocked Comparison of Alternatives A, B, and C (continued)

Lake Name	NPS Lake Code	Reproducing Fish Species/Strains Alternative A	Reproducing Fish Species/Strains Alternative B	Reproducing Fish Species/Strains Alternative C	Fish Species/Strains Used for Stocking Alternative A	Fish Species/Strains Used for Stocking Alternative B	Fish Species/Strains Used for Stocking Alternative C	Initial Stocking Density (fry/acre) Alternative A	Initial Stocking Density (fry/acre) Alternative B	Initial Stocking Density (fry/acre) Alternative C	Frequency of stocking rotation for lakes stocked under Alternatives A, B, and C (x-year cycle)
Pond SE of Kettling Lakes	MR-09-01	—	—	—	OM(MW)	OM(MW)	OM(MW)	50	50	50	5
Quill, Lower[c]	M-24-02	OM	—	—	OM(MW)	OM(MW)	—	25	25	—	5
Quill, Upper[c]	M-24-01	OM	—	—	OM(MW)	Need data OM(MW)	—	25	25	—	5
Rainbow	MR-14-01	OM(PL)	—	—	—	OM(MW)	OM(MW)	—	60	60	4
Rainbow, Upper (South)	MR-13-02	—	—	—	OM(MW)	—	—	70	—	—	4
Rainbow, Upper (West)	MM-11-01	—	—	—	OM(MW)	—	—	50	—	—	10
Ridley	HM-03-01	—	—	—	OM(MW), OM(RL)	OM(MW), OM(RL)	OM(MW), OM(RL)	50	50	50	3
Skymo	PM-03-01	OC	—	—	OM(MW)	OM(MW)	—	50	50	—	4
Sourdough	PM-12-01	SF	—	—	OM(MW)	Need data OM(MW)	—	100	100	—	4
Stiletto	MR-01-01	—	—	—	OM(MW)	Need data OM(MW)	—	50	50	—	6
Stout	EP-09-02	OCL	OCL	—	OCC	OCC	—	100	100	—	5
Stout, Lower	EP-09-01	OCL	OCL	—	—	OM(MW)	—	—	60	—	4
Sweet Pea	ML-02-01	—	—	—	OM(MW)	OM(MW)	—	40	40	—	6
Thornton, Lower	M-20-01	OCL(TL)	OCL	—	OM(MW)	OM(MW)	—	50	50	—	6
Thornton, Middle	M-19-01	—	—	—	OMA	OMA, OM(MW)	—	50	—	—	4
Torment	ML-03-01	—	—	—	OM(MW)	—	—	40	—	—	5
Trapper	GM-01-01	OC	OC	—	—	OM(MW)	—	—	60	—	4
Triplet, Lower	SM-02-01	OCL (TL)	—	—	—	OM(MW)	OM(MW)	—	50	50	1
Triplet, Upper	SM-02-02	OCL (TL)	—	—	—	—	—	—	—	—	—
Triumph	M-17-01	—	—	—	OM(MW), OMA	OM(MW)	—	20, 70	20, 70	—	4

Table 6: Status of Fish Reproduction and Cycle, Stocking Density, and Species of Fish Stocked Comparison of Alternatives A, B, and C (continued)

Lake Name	NPS Lake Code	Reproducing Fish Species/Strains			Fish Species/Strains Used for Stocking			Initial Stocking Density (fry/acre)			Frequency of stocking rotation for lakes stocked under Alternatives A, B, and C (x-year cycle)
		Alternative			Alternative			Alternative			
		A	B	C	A	B	C	A	B	C	
Unnamed	MR-11-01	—	—	—	OM(MW)	—	—	50	—	—	5
Unnamed	MR-16-01	OC	OC	OC	—	OM(MW)	OM(MW)	—	60	60	1
Wilcox/Lillie, Upper	EP-06-01	OC, OM, OM x OC	—	—	—	—	—	—	—	—	—
Wilcox/Sandie, Lower	EP-05-01	OC	—	—	OM(MW)	OM(MW)	—	70	70	—	4
Willow	HM-04-01	—	—	—	OCC	—	—	25	—	—	1

Fish Species Legend

OC – *Oncorhynchus clarki*. This is a generic designation used for cutthroat trout where the subspecies or strain is not known. Usually these fish are Twin Lakes strain westslope cutthroat.

OCB – Yellowstone cutthroat.

OCC – *Oncorhynchus clarki clarki*. A Lake Whatcom strain of coastal cutthroat trout that originated from broodstock collected in Whatcom Lake, Washington.

OCL – *Oncorhynchus clarki lewisi*. Westslope cutthroat trout, strain unknown. A common local name for these fish is "intermontane" cutthroat trout. This subspecies of cutthroat trout is native to the east side of the Cascade Mountains; the west sides of the Rocky Mountains from the Snake River (below Shoshone Falls), north; and the east sides of the Rocky Mountains north of the Yellowstone River.

OCL(TL) – *Oncorhynchus clarki lewisi*. Cutthroat, Twin Lakes strain.

OC(TL) – *Oncorhynchus clarki*. This is a Twin Lakes strain of westslope (intermountain) cutthroat.

OM – *Oncorhynchus mykiss*. This is a genetic designation used for rainbow trout where the subspecies is not known.

OMA – *Oncorhynchus mykiss aquabonita*. This is a subspecies of rainbow trout.

OM(MW) – *Oncorhynchus mykiss*. This is a Mount Whitney strain of rainbow trout originally developed at the Mt. Whitney Hatchery, California, from several subspecies of rainbow.

OM(PL) – *Oncorhynchus mykiss*. This wild strain of rainbow from Packwood Lake in Lewis County, Washington, was the primary sources of rainbow trout broodstock in Washington from 1917 to 1934.

OM(RL) – *Oncorhynchus mykiss irideus*. Ross Lake rainbow trout native to the upper Skagit River watershed; hatched and reared at the Marblemount Hatchery.

SF – *Savelinus fontinalis*. Brook trout are a char native to eastern North America. This fish is often called "Eastern" brook trout in the west, where the name was historically used to distinguish from the rainbow trout (originally called "brook trout").

Notes:

— means category does not apply.

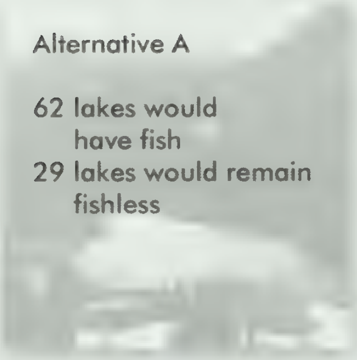
a. "Need Data" indicates lakes where data would have to be obtained prior to deciding whether to stock.

b. In August 2004, a large fish kill was observed in Copper Lake possibly due to disease. Further surveys are needed to confirm that the lake is fishless.

c. Lower Quill and Upper Quill lakes were stocked with nonreproducing fish. Limited reproduction has been observed in the past and needs to be verified.

ALTERNATIVE A
NO ACTION—EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES
(62 LAKES HAVE FISH)

GENERAL CONCEPT



Alternative A

62 lakes would have fish
29 lakes would remain fishless

The guiding regulations (40 CFR 1502.14) of NEPA define the no-action alternative as "no change from current management direction or level of management intensity." Therefore, under this no-action alternative, there would be no change in the way the North Cascades Complex fishery is managed. Lakes that are currently stocked would continue to be stocked, lakes with reproducing fish would be allowed to maintain reproducing fish, and all lakes without fish would continue to be fishless. Because alternative A represents current management, it is also the baseline condition against which the action alternatives are compared.

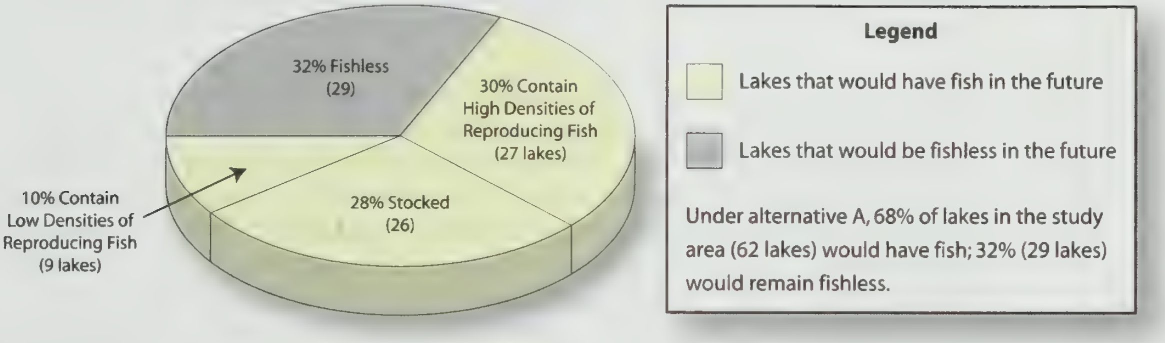
The no-action alternative would continue existing management practices in the 91 lakes slated for management consideration in the study area. Fish occur in 62 of the 91 lakes—these 62 lakes are a subset of the study area's 91 lakes that were once naturally fishless but have a history of stocking or fish presence. The remaining 29 lakes are currently fishless and not actively managed for fish. This would continue under existing management. Of the 62 lakes, 40 are in North Cascades National Park and managed by the WDFW under the terms of the 1988 Supplemental Agreement to the 1985 Memorandum of Understanding (see appendix A). The remaining 22 of 62 lakes are in Ross Lake and Lake Chelan National Recreation Areas. The WDFW manages 19 of the 22 lakes as a recreational fishery; these 19 lakes are not part of the Supplemental Agreement, but are managed by the WDFW according to historical practices. Three of the 22 lakes are also located inside the national recreation areas but are not managed under the 1988 Supplemental Agreement nor are they actively managed by the WDFW. These 3 lakes contain fish: two with reproducing fish populations, and one with nonreproducing populations that were stocked recently enough that some fish still remain.

Reproducing populations of fish are able to sustain themselves over time without further stocking.

The continued stocking of fish in select lakes in the North Cascades Complex has occurred under both the Memorandum of Understanding and the Supplemental Agreement, in addition to a policy waiver issued in 1979 by the director of the NPS and a further policy statement issued by the NPS director in 1986 (see appendix B for the history of fishery management in the North Cascades Complex).

Under alternative A, 62 lakes in the study area would continue to have fish and 29 lakes would be left in their current fishless state, as shown in figure 4.

FIGURE 4: STATUS OF 91 LAKES UNDER ALTERNATIVE A



Under alternative A, 68% of lakes in the study area (62 lakes) would have fish; 32% (29 lakes) would remain fishless.

IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION

The enabling legislation for the North Cascades Complex does not mention fish stocking, and the legislative record regarding fish stocking in the North Cascades Complex is not clear. Therefore, the language in the enabling legislation for the portions of the North Cascades Complex in the national recreation areas does affirm that fishing is an important recreational use, but it does not mention fish stocking as being an appropriate means of fishery management. The *Washington Park Wilderness Act of 1988* (WPWA) established 93% of the North Cascades Complex as Stephen T. Mather Wilderness and directed the NPS to manage the wilderness in accordance with the *Wilderness Act of 1964*. At the time the WPWA was passed, NPS policies prohibited fish stocking in naturally fishless waters, and the WPWA did not include a provision for allowing stocking. (For more detail on legislation and history, please refer to the "History of Fish Management in North Cascades Mountain Lakes" section in the "Purpose of and Need for Action" chapter and Louter 2003).

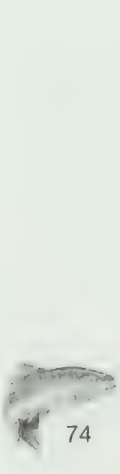
Although the *Wilderness Act* implies that management actions that manipulate natural processes in wilderness conflict with wilderness values, stocking is not expressly prohibited in the Act. According to the definition of wilderness in the *Wilderness Act*, wilderness must retain its "primeval character and influence" so that it "appears to have been affected primarily by the forces of nature." This language has been interpreted in the scientific literature to affirm two closely linked values that are fundamental components of wilderness character: naturalness and wildness. Naturalness has been defined as the native compositions, patterns, and processes of an area. Wildness has to do with ensuring that wilderness areas are minimally influenced by human intervention, so those who enter wilderness can experience primitive and unconfined forms of recreation. Though recreational fishing is widely regarded as an important and traditional use of wilderness, the role of stocking to create and maintain an artificial fishing opportunity in naturally fishless mountain lakes is viewed by many as an artificial manipulation of both wildness and naturalness (Landres et al. 2001). These views are supported by a wide body of scientific research into the impacts of fish stocking, including findings specific to lakes in the North Cascades Complex. However, some disagree with these views and maintain that if nonnative fish were stocked appropriately, there would be no unacceptable adverse impacts on wilderness values because biological integrity would be conserved.

Fish stocking has been allowed to continue in the North Cascades Complex under a 1986 policy waiver (see appendix A). Should a management alternative that allows for continued stocking be selected through this plan/EIS decision-making process, a new policy waiver may not be granted for several reasons. First, various national parks (Sequoia-Kings Canyon National Park, Yosemite National Park, Glacier National Park, Rocky Mountain National Park, and Yellowstone National Park) have discontinued stocking. If this plan/EIS process resulted in the selection of an alternative that allowed for continued stocking, issuance of a policy waiver to the North Cascades Complex could encourage other state fish and wildlife agencies to revisit the issue of stocking in NPS units where stocking has been discontinued. Second, policy waivers are only temporary and do not provide a permanent solution because they can be rescinded as circumstances change. The goal of this plan/EIS is to forge a lasting solution for mountain lakes fishery management in the North Cascades Complex. Finally, the minimum requirements analysis for fish stocking in the Stephen T. Mather Wilderness indicates that stocking is not necessary to meet the minimum requirements for administration of the area, and the *Wilderness Act* is unclear whether stocking is allowed in designated wilderness areas. For these three reasons, a policy waiver would not be pursued if this plan/EIS process resulted in the selection of an alternative that included continued fish stocking.

The NPS has determined that fish stocking in the Stephen T. Mather Wilderness would only be implemented if Congress granted the NPS the unambiguous legal authority to do so. Therefore, should a management alternative that allows for continued stocking be selected through this plan/EIS decision-making process, the NPS intends to ask Congress for a change to the North Cascades Complex enabling legislation to clarify how the mountain lakes should be managed. The following is an example of clarifying legislation that would allow stocking to continue in the national park:

> Notwithstanding any other provision of law, a fisheries management program that includes the stocking of fish in selected lakes within the North Cascades National Park Service Complex is authorized so long as both the National Park Service and the State of Washington agree on the lakes, species of fish, and number of fish to be stocked.

A change in the enabling legislation for the North Cascades Complex to allow for continued fish stocking would set a precedent for this NPS unit, and possibly others that have, or may have in the future, fish stocking issues. If Congress should choose to allow stocking through a change in the enabling legislation, it will have clarified that fish stocking is an appropriate activity in the North Cascades Complex. That unambiguous clarification would allow the NPS to implement any of the management alternatives that include the practice of stocking. Such an action would allow the NPS to proceed with full confidence that it is taking an action that is consistent with the way Congress intended the North Cascades Complex and the Stephen T. Mather Wilderness to be managed.



Congressional action to allow fish stocking would also honor various verbal commitments in support of stocking that proponents believe were made by federal officials prior to establishing the North Cascades Complex but never codified in law.

Congressional action to clarify enabling legislation is an intricate process that could take several years. If the NPS does not receive clarification from Congress by the time a record of decision for this plan/EIS is issued, alternative D (91 Lakes Would Be Fishless) would be implemented until clarification is received.

MINIMUM REQUIREMENTS

Although the *Wilderness Act* implies that management actions that manipulate natural processes in wilderness conflict with wilderness values, stocking is not expressly prohibited in the Act. According to section 4(c) of the *Wilderness Act*, agencies may engage in management actions that may otherwise be prohibited in wilderness provided they are necessary "to meet the minimum requirements for the administration of the area." This provision is commonly referred to as the minimum requirements (or minimum tool) provision. In accordance with NPS policy, a minimum requirements analysis must be completed before a management action can be taken in designated wilderness areas. NPS management policy 6.3.5 states that the purpose of a minimum requirements analysis is (1) to determine whether a proposed action is necessary or appropriate for administration of an area as wilderness and does not pose a significant impact to wilderness resources and character; and (2) if an action is determined to be appropriate or necessary, to determine the techniques and types of equipment needed to ensure that impacts to wilderness resources and character is minimized.

The NPS has conducted a minimum requirements analysis using a decision guide template developed by the Arthur Carhart National Wilderness Training Center (see appendix K). Congress established the Arthur Carhart National Wilderness Training Center in 1993 to "foster interagency excellence in wilderness stewardship by cultivating knowledgeable, skilled and capable wilderness managers and by improving public understanding of wilderness philosophy, values and processes." The minimum requirements decision guide template is used by each of the agencies to assist wilderness managers in making appropriate decisions for wilderness management. The minimum requirements analysis provides a method to determine the necessity of an action in wilderness areas, and how to minimize impacts, but does not bind an agency to take a particular action. Under alternative A, the NPS considers allowing stocking to continue in certain mountain lakes. The results of the minimum requirements analysis show that stocking of nonnative fish to create and enhance an artificial recreational fishery is not necessary to meet the minimum requirements for the administration of the Stephen T. Mather Wilderness (see appendix K). Continuing to stock naturally fishless lakes, as proposed under alternative A, would not leave the wilderness "ideally free from human control or manipulation." Stocking of fish would continue to manipulate the native ecology of a lake and introduce a nonnative species.

Some, including the WDFW, disagree with the conclusions reached in the minimum requirements analysis. They maintain that recreational fishing is allowed under the *Wilderness Act*, and therefore, creating and enhancing fishing opportunities are appropriate actions in wilderness areas. Those who disagree with the conclusions reached in the minimum requirements analysis also believe that if nonnative fish were stocked appropriately, there would be no unacceptable adverse impacts on wilderness values because biological integrity would be conserved. The WDFW's comments on fishery management in the Stephen T. Mather Wilderness accompany the minimum requirements analysis in appendix K.

CURRENT FISHERY MANAGEMENT PROGRAM

CURRENT MANAGEMENT FRAMEWORK

The management framework dictates the parameters under which the fishery management program is applied. The framework controls which lakes are stocked, stocking densities and frequencies, types of fish, methods used for stocking, and monitoring efforts. Under the current management framework for alternative A, the 62 lakes described above under "General Concept" would continue to be managed as they are today. The species currently stocked are the species historically stocked in each lake. The stocking density is guided by two factors: historical stocking densities and adaptive management to achieve maximum sustainable recreational use. Adaptive management can be used to vary the stocking density or frequency in response to reports of extra fishing pressure, low fish numbers, or condition factors. For example, if a lake has historically been stocked at a high density, it might be determined, using an adaptive management approach, that a lower density should be used with the goal of producing fish that are larger or in better condition. Lower densities also help the park meet its goal of minimizing the effect of fish on native biota. Both stocking density and frequency could be lower than planned if the fish required for stocking are not available. Appendix E shows the current status and management of the 91 lakes.

CURRENT STOCKING PROGRAM

Of the 91 lakes under consideration in this plan/EIS, 26 are currently stocked with fish. Of these 26 stocked lakes, 15 are located in the national park and managed in accordance with the 1988 Supplemental Agreement between the NPS and WDFW (see appendix A). Ten of the stocked lakes are located in the national recreation areas, and one is located in the national park but not managed as part of the 1988 Supplemental Agreement; it presently contains fish as a result of unsanctioned stocking.

A lake's physical characteristics help determine the stocking cycle and density. For instance, Ridley Lake is stocked every 3 years with 50 fish/acre (WDFW 2003). The low elevation and relatively high productivity of this lake allow the fish to grow quickly to quality fish size and sustain a more consistent fishery. Ridley also experiences more angler use and is more resistant to impacts from fish due to its lower elevation and high productivity.

Factors such as lake productivity and elevation can also alter the density of fish in a lake. Although these factors were not expressly used to estimate fish densities, other factors and available data were used to derive a relative estimate of density. Appendix H describes the methodology used to estimate current fish density where the density was not known (for both stocked and reproducing fish). Additional fish surveys are planned to determine the reproductive status and abundance of fish in these lakes (WDFW 2003).

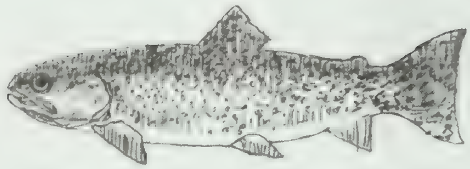
Lakes with High Densities of Reproducing Fish

There are 27 lakes with high densities of reproducing fish, 7 are categorized as "mixed" because the reproducing (self-sustaining) populations are augmented through stocking. To diversify fish availability (thus, fishing opportunity) Berdeen, Skymo, Diobsud No. 2, Monogram, and Sourdough lakes would continue to be stocked with rainbow trout, in addition to the established reproducing (self-sustaining) populations of cutthroat trout (Berdeen, Diobsud No. 2, Monogram, and Skymo) and brook trout (Sourdough) because rainbow trout forage more effectively in the productive deep-water zones compared to cutthroat and brook trout (WDFW 2003). The stocking cycle for these lakes is 4 to 5 years, and stocking density ranges from 50 to 100 fish/acre. There are two exceptions to the 4- to 5-year stocking frequency. Battalion Lake contains reproducing populations of rainbow trout and is supplementally stocked annually with nonreproducing rainbow trout. Lower Wilcox/Sandie Lake contains reproducing cutthroat and rainbow trout and is stocked with nonreproducing rainbow trout on a 4-year cycle at 70 fish/acre.

Of the 27 lakes containing high densities of reproducing fish, 8 lakes would continue to contain high densities of reproducing cutthroat trout; 2 of the 8 lakes (Hozomeen and Lower Blum [West, No. 4]) would contain reproducing brook trout; 2 others (Rainbow and Hanging) would continue to have reproducing rainbow trout; and 4 lakes (Green, Doubtful, Kettling, and Upper Wilcox/Lillie) would contain both cutthroat and rainbow trout.

Lakes with Low Densities of Reproducing Fish

Of the 62 lakes that currently contain fish, 9 are believed to have low densities of reproducing fish; 7 of the 9 lakes are categorized as "mixed" because they contain self-sustaining populations of trout that are augmented through stocking. To diversify fishing opportunity, Middle Blum, Firn, Upper Dee Dee, Lower Thornton, and Hidden Lakes would continue to be stocked with rainbow trout, in addition to the established reproducing populations of rainbow trout (Middle Blum and Hidden) and cutthroat trout (Firn and Lower Thornton) present in these lakes. Marginal reproduction occurs in Hidden Lake, and the level is believed to be too low to sustain a population or fishery; therefore, Hidden Lake would continue to be managed as a stocked lake despite its mixed-management status (WDFW 2003). The stocking frequency for these lakes is 4 to 6 years, and stocking density ranges from 20 to 50 fish/acre. Stout Lake would continue to be stocked with coastal cutthroat trout (which are native to the watershed) in an effort to replace, over time, an existing population of westslope (intermountain)



Coastal cutthroat is a native fish found in the west-side drainages of the national park.

cutthroat. The intent is to reduce or eliminate the potential for downstream hybridization of westslope cutthroat with coastal cutthroat trout. Three of the 9 low-density lakes (Jeanita, Hidden Lake Tarn, and Lower Thornton) are on longer stocking frequencies than other stocked lakes (WDFW 2003). The longer time between stocking (6 to 7 years) helps promote optimum growth rates (resulting in larger fish) and reduces fishing pressure because fish populations are smaller near the end of stocking cycles as nonreproducing fish have been removed by fishing or natural causes.

Fishless Lakes

The remaining 29 lakes in the study area are currently fishless and would remain fishless under alternative A.

Current Stocking Practices

Stocked-only Lakes. Mountain lakes are generally stocked by the WDFW at densities of 50 to 100 fish/acre. Backpack stocking is used to minimize impacts on wilderness values and is used in almost all of the stocked lakes in the national park. Stocking frequencies (cycles) can vary from 1 to 10 years between stocking times. Most lakes in the North Cascades Complex are managed for 4- to 5-year cycles. Some lakes are on longer cycles to allow a period of several years when few or no fish are present, and other lakes are on short stocking cycles. Lakes on long cycles experience a “resting period,” which gives prey species an opportunity to reach their maximum densities. Resting periods also help reduce fishing pressure because anglers may not fish in a lake if they are unsure of fish availability and might only fish in that lake when the combination of density and fish size is appealing. Some lakes with low levels of reproducing fish are stocked to bring densities up to fishable levels or increase fish availability without exceeding densities that would impact these lakes. Lakes with high growth rate for stocked fish are often managed on short stocking cycles with a small number (less that 50 fish/acre) to produce a more consistent fishery. Lakes that experience high levels of fishing pressure (and high angling mortality of stocked fish) are also frequently managed on a short stocking cycle because fish densities drop quickly once stocked fish become large enough to interest anglers (fish generally become large enough for the sports fishery at two to three years of age).

Lakes that are Both Stocked and have Reproducing Fish. A lake may have a mixed population of fish for one of several reasons.

> *To Supplement Low Rates of Reproduction (low recruitment)* Lakes with low levels of reproducing fish that cannot, under current fishing pressure, support densities of more than a few dozen fish per acre are often supplemented by stocking nonreproducing hatchery fish at high enough levels to maintain fishable, but relatively low (less that 100 fish/acre) densities of fish.
>
> *To Use Pelagic (Deep Water) Habitat and Increase Diversity of Fishing Opportunity* Lakes with established reproducing populations of fish

(generally westslope cutthroat or brook trout), which primarily feed on macroinvertebrates found on lake bottoms in the near-shore zone, sometimes are stocked with Mt. Whitney rainbows, which feed extensively on zooplankton in the open water zone of mountain lakes. This management practice more fully utilizes the available resources of a lake for fish production and adds an additional species to the lake, diversifying the angling experience.

To Replace an Undesirable Stock (Genetic Swapping) Coastal cutthroat (Lake Whatcom strain) are currently being stocked in Stout Lake, which contains a reproducing population of westslope cutthroat trout. The object of stocking coastal cutthroat is that the westslope cutthroat trout are not native to the watershed below Stout Lake, as are the coastal cutthroat. Large numbers of native coastal cutthroat are stocked with the hope they would interbreed with the nonnative westslope cutthroat trout and replace the existing population of fish with a crossbred population that either primarily represents the genotype of coastal cutthroat or is close enough to the phenotype of coastal cutthroat that they are not a threat to populations of native rainbow, coastal cutthroat, and native char in the basin below the lake.

Genotype: The genetic makeup of an organism as opposed to its physical characteristics.

Species and Strains of Fish Currently Stocked and Current Stocking Cycles and Density. Table 6 and appendix E show the species of fish currently present in North Cascades Complex lakes managed by the WDFW and the species and strains of fish used for stocking. A description of the fish used in stocking can be found under the "Aquatic Organisms" section in the "Affected Environment" chapter.

Phenotype: The visible characteristic of an organism resulting from the interaction between its genetic makeup and the environment.

Specific Times of Year When Stocking Currently Takes Place. High-elevation lakes are always stocked during the ice-free period, which varies from year to year, but is generally between mid-July to mid-September. Stocking can start as early as May in lower-elevation lakes or as late as the end of October in higher-elevation lakes that ice-out later. Stocking later than October is avoided because survival is sharply reduced if fry do not have time to acclimate to a lake and its food supply before winter (WDFW 2001). Mt. Whitney rainbow and Twin Lakes cutthroat trout are preferred for stocking mountain lakes because it is possible to rear them to an appropriate size for stocking during the summer months after ice-out. Ross Lake rainbow trout fry also reach suitable sizes for summer stocking at the appropriate time. Lake Whatcom strain cutthroat fry, however, normally are too large during the summer months for stocking by backpack or fixed-wing aircraft; therefore, hatching is delayed by chilling the water used to incubate their eggs.

CURRENT LAKE TREATMENTS TO MANAGE THE FISHERY

Under alternative A, no lakes are treated to remove fish.

Mechanical Methods

Under alternative A, no mechanical methods of fish removal are used.

Chemical Methods

Under alternative A, no lakes are chemically treated to remove fish.

Natural Methods

None of the lakes in the national park that are managed by the WDFW under the 1988 Supplemental Agreement or in the national recreation areas are allowed to become fishless by the cessation of stocking.

CURRENT MITIGATION

See appendix I for a description of current mitigation practices used to minimize potential impacts of fish stocking.

CURRENT MONITORING PROGRAM

Fishery managers currently rely on high-lake angler report cards and periodic surveys with gillnets to understand fish stock conditions. Most angler reporting originates with members of the Hi-Lakers and Trail Blazers. Anglers volunteer to collect information that yields estimates of fish abundance, growth, and species composition, as well as angler effort, success, and usage. From 1968 to 2001, 133 anglers filed 90 reports for 31 lakes in the North Cascades Complex. Because it is sporadic, this information cannot be used to confidently report whether a particular fishery is thriving or failing. However, this information, combined with data gathered by NPS staff from net sets, does provide an important source of data on the 91 lakes in the study area (WDFW 2003).

Resource management activities in the North Cascades Complex in recent years have focused on improving the baseline knowledge of both natural and cultural resources in the park, as part of the NPS Natural Resource Challenge Initiative. The Initiative is an effort to improve management decisions by enhancing knowledge and understanding of NPS resources. In support of this effort, Congress is providing funding for inventorying, monitoring, restoration, research, and education. The aquatics program has focused on monitoring salmon in the Skagit River and its tributaries, stream resident fish populations throughout the North Cascades Complex, and on benthic (bottom dwelling) macroinvertebrate monitoring in streams and lakes throughout the North Cascades Complex. To improve knowledge of amphibian distributions, park biologists have also been systematically inventorying the distribution and abundance of amphibians in terrestrial and aquatic habitats.

Benthic: Occurring at the bottom of a body of water.

The data provided by these monitoring efforts have been used in developing this plan/EIS.

COST OF IMPLEMENTATION

Not accounting for inflation, the estimated total costs for continuation of the current management program under alternative A over the next 15 years would be $270,000. For more details on cost of continuing management under alternative A, see the "Management and Operations" section in the "Environmental Consequences" chapter.

ELEMENTS COMMON TO ALL ACTION ALTERNATIVES

MANAGING NORTH CASCADES AS A COMPLEX, AS OPPOSED TO DISCRETE UNITS

The enabling legislation for the North Cascades Complex provides separate guidance for administration of the national park and the two national recreation areas. In 1970, however, Congress declared that the NPS was to treat equally all of the areas under its charge, especially in the protection of their natural values (*General Authorities Act*, 16 USC section 1a-1). Therefore, the objectives of this plan/EIS apply equally to the recreation areas, as well as the national park.

MONITORING, DATA COLLECTION, AND FUTURE MANAGEMENT OF LAKES

Monitoring and evaluation are crucial in determining if management actions are achieving objectives. For instance, if a stocked lake begins to show unacceptable effects on native biota, that lake would be managed differently (such as reducing the density of stocked fish, changing stocking cycles, changing fish species stocked, or stopping fish stocking completely). This process of using information as it becomes available to alter management actions is called adaptive management, which is explained in the next section. This process recognizes the importance of continually learning how to manage better. Instead of adhering rigidly to a standard set of management actions, the goal is to build flexibility and adaptation into management actions. As a result of this process, the management action initially applied could be altered. These alterations may include reducing fish densities, changing stocking cycles, changing species stocked, or completely removing fish. Each action alternative in this plan/EIS employs an adaptive management element involving monitoring and evaluation. This means that, although each alternative predicts the number of lakes that would be managed by specific actions, ultimately, some of those actions may change as knowledge is gained.

The NPS would rely primarily upon soft funding (short-term sources of special funding) to implement the plan because there is no base funding available or anticipated for the foreseeable future to manage the mountain lakes fishery. Reliance on soft funding means the plan would be implemented in a piecemeal fashion as funding becomes available. The impact of this funding strategy on park operations is described in the "Management and Operations" section in the "Environmental Consequences" chapter.

ADAPTIVE MANAGEMENT

Adaptive management is based on the premise that managed ecosystems are complex and unpredictable. Adaptive management is an analytical process for adjusting management and research decisions to better achieve management objectives. This process recognizes that our knowledge about natural resource systems is uncertain; therefore, some management actions are best conducted as experiments in a continuing attempt to reduce the risk arising from that uncertainty. The goal of such experimentation is to find a way to achieve the objectives while avoiding inadvertent mistakes that could lead to unsatisfactory results (Goodman and Sojda 2004).

The NPS must use adaptive management to fully comply with Council on Environmental Quality regulations (40 CFR 1500) requiring the adoption of a monitoring and enforcement program. Adaptive management (516 Department Manual [DM] 4.16) is a system of management practices based on clearly identified outcomes; monitoring to determine if management practices are meeting outcomes; and if they are not, facilitating management changes that would best ensure that outcomes are met. The NPS must keep the public and affected regulatory and permitting agencies informed throughout the application of adaptive management. The NPS is also to provide post-activity opportunity for the public and affected agencies to review adaptive management practices (NPS 2001b, 1.1).

Implementing adaptive management is neither simple nor intuitive. It is complex because of the large number of interconnected potential scenarios, the related uncertainties, and the intricacy of necessary computations. Adaptive management is a central theme of the three action alternatives analyzed in this plan/EIS, and monitoring of the lakes is a key component of adaptive management. Adaptive management is an iterative process of applying management actions, monitoring consequences, evaluating monitoring results against objectives, adjusting management actions, and using feedback to make future management decisions. The adaptive management process for the 91 lakes in the study area would evaluate the effects of management actions (for example, allowing management of low densities of nonreproducing fish) on biological resources at an individual lake and identify whether the management action should be modified to meet the objectives for the lake. Monitoring is intended to test the success and efficacy of management actions at each lake; therefore, the proposed monitoring plan for the mountain lakes fishery (see appendix F) would provide the basis for the monitoring activities.

The specific objectives of monitoring are to

> reduce uncertainty of current conditions by gathering additional information where data are lacking.
>
> develop and refine protocols for collecting data that are cost effective, efficient, and explicitly linked to management actions.
>
> develop thresholds/criteria for data evaluation that will facilitate the adaptive management process.

perform adaptive management by evaluating the success or failure of management actions to conserve/improve biological integrity and provide quality fishing opportunities.

Under this plan/EIS, the six steps listed below would be followed when applying an adaptive management approach:

1. Existing conditions would be monitored to establish a set of baseline conditions, such as fish density, for a given lake.
2. The lake would be treated using one of the methods described in this document; for example, removing fish with antimycin or stocking the lake with low densities of nonreproducing fish.
3. The lake would be monitored for effects resulting from the management action. For example, the effects of antimycin on fish and the surrounding environment, including other organisms, would be observed and recorded. In another example, the effects of fish on the surrounding environment would be observed and recorded.
4. Based on the results of monitoring, the management action or lake treatment method would be reconsidered. A monitoring plan (see appendix F) that addresses these thresholds would be developed. If monitoring results indicated that a threshold had been exceeded, the NPS would consider applying a different type of treatment. For example, after applying a management action that allows fish in a lake, the NPS may alter the management action to reduce the density of stocked fish, change species stocked, or remove fish.
5. If the management action or lake treatment worked effectively, and no thresholds were exceeded, no change would be made to the process.
6. If results of the treatment or management action were acceptable, and no thresholds were exceeded, then the NPS would continue to apply the management action or treatment. For example, if antimycin effectively killed fish and did not harm other species or the surrounding environment, antimycin would continue to be applied in other lakes.

Adaptive management combines the advantages of scientific method with the flexibility to address the human and technical complexities inherent in managing complex environmental issues. The goal is to give policy makers a better framework for applying scientific principles to complex environmental decisions (Wall 2004). This process is illustrated in figure 5.

OUTREACH AND EDUCATION

Education and public outreach would be a large component of all action alternatives. The NPS would establish a long-term public outreach campaign to help educate and inform the public about the selected alternative. A focused

FIGURE 5: ADAPTIVE MANAGEMENT PROCESS

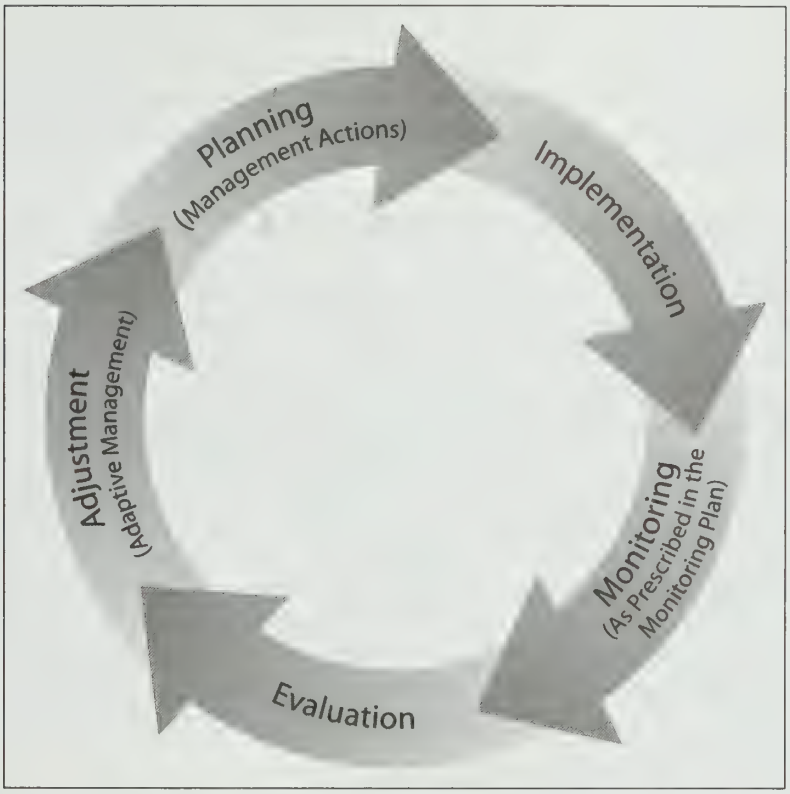


exhibit would be developed for the North Cascades Complex's two visitor centers. The NPS would also maintain a web page that presents a clear, concise, and illustrated explanation of the issue and its resolution, including multiple links from parts of the North Cascades Complex website used by backcountry travelers and mountain lake anglers. A paper version in the form of a brochure would be distributed at the visitor centers and at fairs and festivals where the North Cascades Complex is represented. The NPS would encourage media coverage of the fish removal work in the field by contacting reporters who have in the past covered science and resource management stories at the North Cascades Complex.

PARTNERSHIPS

The NPS would actively seek partnerships with the WDFW, fishing groups, and the public to implement fishery management actions. Personnel from the WDFW would also assist with fish removal. They would provide important field and logistical support and serve as an interface with various fishing groups. Local fishing groups have long been concerned about lakes with reproducing fish populations because they yield stunted fish and a poor fishing experience. These groups have expressed a strong desire to help with fishery management actions in the North Cascades Complex, and they would also be asked to assist with fish removal (NPS 2004).

Alternative D would eventually eliminate the mountain lakes fishery from the North Cascades Complex, and it may be unlikely that a partnership would be formed with WDFW or local fishing groups because they would have no incentive to participate. The NPS would still seek to form partnerships under alternative D, but with other partners, such as conservation organizations that may support the objective of complete elimination of the mountain lakes fishery.

LAKE TREATMENT METHODS

Each lake has its own particular chemical and physical characteristics that dictate the best means of removing fish; therefore, methods of removing fish would differ among lakes, but the prescribed method of fish removal for a particular lake would not differ across the alternatives. There are three general methods of removing fish: mechanical, chemical, and natural. Each category includes one or more types of treatment, which are described in the following sections. Table 7 shows what lakes would be candidates for the mechanical and chemical treatment methods. In order to minimize any potential impact from lake treatment methods, mitigation measures have been identified for each type of treatment (see appendix I for a full description of current and proposed mitigation practices).

Mitigation: Activities that can prevent, reduce, or compensate for adverse environmental impacts.

MECHANICAL METHODS

Intensive Gillnetting/Electrofishing/Trapping

The three intensive mechanical methods of removing fish (gillnetting/electrofishing/trapping) would not be used independently but in combination to treat appropriate lakes. A varied combination of gillneting, electrofishing, fyke nets, and traps near spawning areas would be used to catch and remove fish from lakes generally smaller than 5 acres in surface area and less than 30 feet deep. The exact choice of equipment would depend upon lake conditions. To minimize use of the piscicide, antimycin, these methods might also be tried on larger shallow lakes, provided they do not have complex substrate or other conditions that might make removal infeasible.

Fyke Net: A fish trap shaped like a bag, cylinder, or cone mounted on rings, with funnels that direct fish into successive compartments; also called a wing net.

Ecological and social concerns about using piscicides have prompted researchers to experiment with mechanical methods of removing and controlling fish. For small mountain lakes, the method that has shown the most promise is gillnetting in combination with electrofishing.

Each gillnet contains different mesh sizes in order to catch fish of different sizes. NPS personnel would place a large number of nets (from 15 to 30) in a lake like spokes of a wheel around the lake perimeter, with the smallest mesh near the shore where smaller fish tend to congregate. Larger mesh would be placed in deeper water to trap larger fish. Weighted nets would sink to the bottom and would include a floating line for retrieval. Nets and other equipment would be transported to the lakes by helicopter and placed from the shore and by a crew member using a boat or float tube (NPS, R. Zipp, pers. comm., 2003).

At Mount Rainier National Park, the NPS has successfully used gillnetting as a mechanical method for removing reproducing populations of fish in relatively small, shallow lakes (OSU, B. Hoffman, pers. comm., 2003). In the Sierra Nevada mountain range, researchers have successfully removed reproducing populations of fish using gillnets in lakes as large as 4 acres and 20 feet deep (Knapp and Matthews 1998). Based on this research, an intensive fish removal program using gillnets to remove fish from small lakes (less than 5 acres) is now underway at Sequoia Kings Canyon National Park (NPS, D. Boiano, pers. comm., 2003).

Researchers in the Canadian Rockies have also successfully removed reproducing fish using gillnets in small lakes (less than 5 acres and less than 30 feet deep) that do not have inlet or outlet streams (Parker et al. 2001). These successful case studies have prompted various estimates of gillnetting effectiveness. Lake size and depth seem to be the primary criteria that determine success or failure of gillnetting. For example, Knapp and Matthews (1998) suggest that gillnetting is a viable method for fish removal in lakes less than 7 acres and less than 33 feet. In contrast, Parker et al. (2001) suggest that gillnetting can be an effective management tool in lakes less than 25 acres and less than 33 feet deep.

There is no consensus among researchers or fishery managers as to the maximum size or depth that should be considered the “upper limit” for the usefulness of gillnets as a fish removal method. Many factors must be considered, such as lake size, depth, cost, accessibility, the presence of inlet and outlet streams, water quality, and the target fish species (Knapp and Matthews 1998; Parker et al. 2001).

The complexity of a lake’s habitat can create difficulties when removing fish with gillnets. For example, large amounts of submerged woody debris, possibly deposited in the lake from natural events (such as avalanches), could cause nets to snag and could also be used by fish for hiding, thus avoiding the nets. Shoreline complexity, such as steep slopes, rocky terrain, or dense vegetation, could also make placing nets difficult (OSU, B. Hoffman, pers. comm., 2003). Nets would be left in a lake overnight. Small crews of NPS personnel would camp near the lake for several days, checking the nets daily and removing trapped fish. Dead fish would be disposed of in the deepest parts of the lake and would sink to the bottom (fish air bladders would be punctured to ensure they do not float). Nets would periodically be moved to different locations in the lake because fish learn to avoid nets placed in one location for long periods. One crew member would remove fish from nets using a float tube, flippers and waders, or a raft, depending on conditions. Another crew member would remain on shore to record data and monitor the safety of personnel. Crews would store nets in a bear-proof box located near the lake upon leaving the site to ensure that bears would not be attracted to the smell of the nets.

Gillnetting would be costly and very time consuming and could result in injury or death to nontarget organisms such as waterfowl, mammals, and amphibians. These impacts are discussed in the “Environmental Consequences” chapter along with various mitigation measures that would be used to minimize harm to nontarget organisms.

TABLE 7: MECHANICAL AND CHEMICAL TREATMENT METHODS FOR LAKES WITH REPRODUCING NONNATIVE FISH

Lake Name	NPS Lake Code	Depth (feet)	Area (acres)	Trout/Char Species	Proposed Fish Removal Treatment Methods[a]		
					Alternative B	Alternative C	Alternative D
Battalion	MLY-02-01	16	6.3	Rainbow	Chemical[b]	Chemical	Chemical
Bear[c]	MC-12-01	152	25.7	Cutthroat	Chemical	Chemical	Chemical
Berdeen[c]	M-08-01	215	126.7	Cutthroat	Chemical	Chemical	Chemical
Berdeen, Lower	M-07-01	36	7.5	Cutthroat	Chemical	Chemical	Chemical
Berdeen, Upper	M-09-01	Unknown	9.5	Cutthroat	Chemical	Chemical	Chemical
Blum (Largest/ Middle, No. 3)[d]	M-11-01	42	12.9	Brook	Chemical	Chemical	Chemical
Blum (Lower/West, No. 4)	LS-07-01	26	6.4	Brook	Chemical	Chemical	Chemical
Bouck, Lower	DD-04-01	63	10.8	Cutthroat	Chemical	Chemical	Chemical
Dagger	MR-04-01	16	8.2	Cutthroat	Chemical	Chemical	Chemical
Dee Dee, Upper	MR-15-01	89	12.2	Rainbow	Mechanical[b]	Mechanical	Mechanical
Diobsud No. 1, separate, not connected	LS-01-01	11	1	Cutthroat	Mechanical	Mechanical	Mechanical
Diobsud No. 2, Lower	LS-02-01	17	3.1	Cutthroat	Mechanical	Mechanical	Mechanical
Doubtful	CP-01-01	68	30.2	Cutthroat, Rainbow	Chemical	Chemical	Chemical
Doug's Tarn	M-21-01	10	5.0	Cutthroat	Mechanical	Mechanical	Mechanical
Firn	MP-02-01	38	5.7	Cutthroat	Data Needed[e]	Chemical	Chemical
Green[c]	M-04-01	153	80.0	Cutthroat, Rainbow	Chemical	Chemical	Chemical
Hanging[c,f]	MC-08-01	Unknown	88.8	Rainbow	Chemical	Chemical	Chemical
Hidden[c]	SB-01-01	258	61.7	Rainbow	NA[g]	Chemical	Chemical
Hozomeen[c]	HM-02-01	67	97.4	Brook	Chemical	Chemical	Chemical
Ipsoot	LS-06-01	51	8.9	Cutthroat	Data needed	Chemical	Chemical
Jeanita	DD-01-01	8	1.4	Rainbow	Data needed	Mechanical	Mechanical
Kettling	MR-05-01	23	9.9	Cutthroat, Rainbow	Chemical	Chemical	Chemical
McAlester	MR-10-01	23	13.2	Cutthroat	Chemical	Chemical	Chemical
Monogram[c]	M-23-01	122	29.1	Cutthroat	Chemical	Chemical	Chemical
Rainbow	MR-14-01	108	15.5	Rainbow	Chemical	Chemical	Chemical
Skymo	PM-03-01	20	10.8	Cutthroat	Chemical	Chemical	Chemical
Sourdough	PM-12-01	107	27.6	Brook	Chemical	Chemical	Chemical
Stout[c]	EP-09-02	176	25.2	Cutthroat	Data needed	Chemical	Chemical
Stout, Lower	EP-09-01	8	1.0	Cutthroat	Data needed	Mechanical	Mechanical
Thornton, Lower	M-20-01	108	55.1	Cutthroat	NA	Chemical	Chemical
Trapper[c]	GM-01-01	161	147.2	Cutthroat	Data needed	Chemical	Chemical

TABLE 7: MECHANICAL AND CHEMICAL TREATMENT METHODS FOR LAKES WITH REPRODUCING FISH (CONTINUED)

Lake Name	NPS Lake Code	Depth (feet)	Area (acres)	Trout/Char Species	Proposed Fish Removal Treatment Methods[a]		
					Alternative B	Alternative C	Alternative D
Triplet, Lower	SM-02-01	7	2.2	Cutthroat	Mechanical	Mechanical	Mechanical
Triplet, Upper	SM-02-02	13	2.3	Cutthroat	Mechanical	Mechanical	Mechanical
Unnamed	MR-16-01	7	1.9	Cutthroat	Data needed	Data needed	Mechanical
Wilcox/Lillie, Upper	EP-06-01	65	10.5	Cutthroat, Rainbow	Mechanical	Mechanical	Mechanical
Wilcox/Sandie, Lower	EP-05-01	20	5.4	Cutthroat, Rainbow	Mechanical	Mechanical	Mechanical

Notes:

a. Experience and knowledge gained in removing fish from these lakes would be used in an adaptive management fashion to refine treatment methods for removing fish in the remaining lakes; therefore, proposed treatment methods could change as new information emerges. For this plan/EIS, however, the impact analysis of fish removal (see the "Environmental Consequences" chapter) assumed that treatment methods would be performed as indicated in this table. Complete removal of fish may not be feasible for these lakes.

b. "Chemical" means that chemical methods would be limited to application of antimycin (trade name Fintrol®), a potent, yet short-lived, piscicide (fish toxicant).

"Mechanical" means that mechanical treatment methods would include gillnetting in combination with electrofishing, hook and line, fyke nets, and cobbling over of spawning habitat. Fish removal using either mechanical or chemical methods may not be feasible for some lakes; a feasibility analysis is provided later in this chapter.

c. Lakes where complete removal of fish may not be feasible. See further discussion and explanation of assumptions in this section and in table 8.

d. Lakes highlighted in gray would be among the first lakes to undergo fish removal.

e. "Data needed" means that additional data are needed to determine whether fish should be removed under alternative B.

f. Remove all reproducing fish pending agreement with British Columbia.

g. "NA" means that fish removal is not part of the overall management action for the respective alternative.

Netting would likely occur over a 2- or 3-year period and would be repeated until the amount of fish caught decreased to zero. When fish were no longer caught, the nets would be placed a few more times to reaffirm that all fish had been removed.

Nets would be placed during the ice-free seasons (summer and fall), and the duration would depend upon lake location. Lakes at lower elevations thaw in April and May, and lakes at higher elevations thaw in July and August (some lakes are ice-free for only one or two months out of a year) (Liss et al. 1995).

Monitoring protocols would be used to document the recovery of native biota in the lakes, with an emphasis on measuring the abundance and diversity of various indicator taxa (amphibians, large crustacean zooplankton, and macroinvertebrates) known to be sensitive to fish predation.

Electrofishing would be used in conjunction with gillnets to catch and remove fish from habitable inlet or outlet streams. With this method, fish would be electrically stunned by crews using either a gasoline- or battery-powered backpack-mounted generator. Due to minimum tool concerns in wilderness, preference would be given to solar-rechargeable batteries rather than gas generators. Fish caught in the electrical current created by this method would be stunned or killed by an electrical field. Dead fish would be netted, and shocked

fish would be killed by NPS crews. As described earlier, the fish would then be disposed of in the deepest part of the lake to sink to the bottom (NPS, R. Zipp, pers. comm., 2003).

Electrofishing is not effective in lakes with low ionic (containing matter in the form of charged atoms or groups of atoms) content, such as those in the study area, because the current does not carry very far through the water. However, because the electrical current travels only short distances, it is effective for removing fish in small, shallow inlet and outlet streams and in areas that are hard to access with nets (NPS 2004). Candidates for the electrofishing method are inlet and outlet streams of lakes that are gillnetted.

Traps (entrapment gear) would be used in conjunction with gillnets to catch and remove fish near inlet or outlet streams. Fyke nets would be set in lakes near the mouths of tributaries and lake outlets where trout congregate to feed or spawn. One or more wings of netting attached to the fyke net mouths would be set perpendicular to the movement of the fish to guide them into the enclosure or "pot" of the net, where they would be collected daily. Fyke nets use a finer mesh than gillnets and are more efficient in capturing juvenile trout. Small traps, such as minnow traps, could be used effectively to remove juvenile trout from lakes and shallow inlet/outlet streams. Fish removed from traps would be killed by NPS crews and, as described earlier, placed in the deepest part of the lake to sink to the bottom.

Spawning Habitat Exclusion

Most fish species spawn in the gravelly, highly oxygenated areas of moving water found in outlet and inlet streams. Certain large lakes in the North Cascades Complex, such as Upper Wilcox/Lillie Lake, appear to have limited spawning habitat in their inlet and outlet streams. Fishery management experts have suggested that a simple and effective method for reducing or eliminating fish reproduction (and eventually eliminating fish or reducing fish densities), would involve blocking access to spawning grounds by "cobbling over" gravel beds (WDFW 2001). This approach has been successfully used on an experimental basis in the Sierra Nevada mountain range (NPS, D. Boiano, pers. comm., 2003; NPS 2004; NPS, R. Zipp, pers. comm., 2003).

Without spawning habitat, fish would not successfully reproduce, thereby breaking the reproductive cycle. Some species (such as brook trout) can spawn along the shoreline or where upwellings of ground water occur (Behnke 2002), so lakes would have to be carefully selected for this type of fish removal (NPS, R. Zipp, pers. comm., 2003).

In lakes with limited spawning habitat, such as Wilcox/Lillie, Upper, NPS crews and volunteers could hand-carry small rocks from adjacent areas (such as talus slopes) and place them over spawning gravels. Field surveys indicate that spawning habitat at Wilcox/Lillie, Upper is limited to a 30-foot section of the inlet streambed. A large supply of cobble is readily available from an adjacent talus slope, so crews would transport small rocks a short distance to block access to spawning gravels in the inlet or outlet stream. Although labor intensive, this approach could provide a useful, minimally invasive tool for removing fish from other large lakes with limited spawning habitat (NPS 2004).

Lakes that would be candidates for this method are those that contain very limited spawning habitat and do not contain brook trout.

CHEMICAL METHODS

The following provides an overview of the use of antimycin and its effects. For more information, see the "Environmental Consequences" chapter.

Antimycin

Piscicides, including rotenone and antimycin, have been used to remove fish from mountain lakes. Rotenone has traditionally been used to remove fish from lakes and streams; however, rotenone is toxic to a variety of aquatic organisms and can be harmful to people who apply it, so special handling is required. Rotenone often eliminates crustacean zooplankton immediately, and amphibian larvae and metamorphosing amphibians are vulnerable to normal treatment concentrations of rotenone (Bettoli and Maceina 1996). Rotenone is also less effective on fish in the cooler water temperatures found in mountain lakes. For these reasons, the park would not select rotenone as its first choice for a chemical treatment, but if antimycin (the first choice for chemical treatment) proved ineffective, rotenone could be considered for use. Use of rotenone would require additional analysis of environmental impacts in compliance with NEPA. This analysis would include public comment and input.

Piscicides:

Chemicals such as rotenone and antimycin that are used to remove fish from lakes.

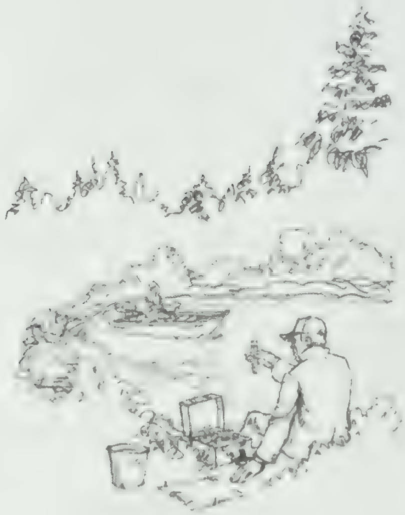
The discovery of the piscicidal (fish killing) properties of the antibiotic antimycin in the early 1960s provided biologists with another chemical that can be used for fish removal (Derse and Strong 1963; Bettoli and Maceina 1996). Antimycin has shown several advantages over rotenone: it is more effective in killing fish (Bettoli and Maceina 1996; Berger et al. 1969; Rosenlund and Stevens 2002); is more effective in colder water; works well in water up to a pH of about 8; and, most importantly, has relatively small and short-term effects on other aquatic life when applied at piscicidal concentrations. Small amounts of the chemical are required to kill fish because antimycin is toxic to fish in extremely low concentrations. Antimycin has other advantages over rotenone; for example, trout do not avoid waters treated by antimycin. Also, when the elevation of a lake outlet stream drops 260 to 500 feet, it appears that antimycin naturally degrades. This apparent degradation has been attributed to rapid oxidation in turbulent waters (Rosenlund and Stevens 2002). In aquatic environments, antimycin enters the fish gills and irreversibly blocks cellular respiration (Rosenlund and Stevens 2002). The concentration of antimycin necessary to remove fish has a fairly wide range of impacts on aquatic organisms, depending upon taxonomic groups. For example, the toxicity of antimycin to aquatic invertebrates is similar to that of fish (Finlayson et al. 2002). Antimycin is considered to be harmless to waterfowl, mammals, and humans at the relatively minute (4–8 parts per billion) concentrations needed to control trout (Rosenlund and Stevens 2002; Schnick 1974).

Taxon or taxa (pl.):

Category of organisms. Any of the groups to which organisms are assigned according to the principles of taxonomy, including species, genus, family, order, class, and phylum.

Antimycin has been used to remove nonnative trout from many lakes, reservoirs, and streams in the western United States. The NPS and U.S. Fish and Wildlife Service, for example, have successfully used antimycin since 1973 to remove nonnative trout and restore native greenback cutthroat trout in Rocky Mountain National Park and the headwaters of the Leadville National Fish Hatchery. In addition, antimycin has been used in a lake in Great Basin National Park and a stream at Crater Lake National Park. Use of antimycin at Rocky Mountain National Park has demonstrated that dose concentrations as low as 2 parts per billion can be very effective in removing trout from cold, neutral pH lakes. Given the successful use of antimycin in Rocky Mountain National Park, its limited toxicity to nontarget species, and its rapid degradation, antimycin would be the preferred piscicide for fish removal under the alternatives in this plan/EIS.

The only commercially available form of antimycin is Fintrol®, a restricted-use pesticide with U.S. Environmental Protection Agency registration number 39096-2. Fintrol® is sold in 20% liquid concentrate form as a fish toxicant kit that includes 240 cubic centimeters (cc) of Fintrol® concentrate and 240 cc of a diluting agent (that is, a substance that allows antimycin to mix with water). The diluting agent and concentrate are mixed together to form one unit of antimycin that is designed to treat still and running waters. One unit of antimycin (480 cc) can treat 38 acre-feet of water at a concentration of 1 part per billion. For more information, a copy of the Fintrol® label and published application instructions are provided in appendix L. (Note: 1 cc equals about .034 ounce.)



Prior to the application of antimycin, biologists would obtain lake information such as volume, water flow from any inlet or outlet streams, fish species present, water temperature, and pH.

The amount of antimycin required to kill fish would be determined by gathering the following information: an accurate estimate of lake volume and water flow into and out of the lake, the species of fish present, water temperature, and pH (Rosenlund and Stevens 2002). Antimycin requires a certain amount of contact time with fish in order to be effective, and the amount of time varies; for example, lakes with shorter residence times (time required for water to flow through the lake) would require a higher concentration (Rosenlund and Stevens 2002). Crustacean zooplankton exposed to temporarily higher concentrations near inlet streams may be affected, and some mortalities could occur even at normal treatment concentrations. No mortalities are known to occur in vertebrates through direct or indirect contact or consumption of antimycin-killed fish (Gilderhus 1969). Mammals can be sensitive to antimycin, although not at concentration levels proposed for treatment. Furthermore, the degradation products of antimycin are not believed to be toxic (Bettoli and Maceina 1996).

Due to the weight and volume of the chemical and the equipment needed for application, a helicopter would deliver the chemicals, application equipment, and a lightweight portable boat with an outboard motor to all lakes requiring chemical treatment (NPS, R. Zipp, pers. comm., 2003). A grid pattern across the lake would be used for applying the treatment by boat, and application rates would be based on calculations of lake volume and residence time. Antimycin would be diluted with lake water and then injected into the prop wash of a small motor. Bilge pumps would also be used to help mix the chemical in deeper water (Rosenlund and Stevens 2002). A bucket containing dilute antimycin would drip the piscicide into streams flowing into the lake to carry a plume of piscicide into deeper lake water. Because water entering the lake from streams is usually colder than lake water, the drip station set at these locations would help mix the chemical with this colder water that would sink to the lake's bottom (NPS, R. Zipp, pers. comm., 2003). Crews on the shoreline would use a diluted mixture of antimycin to hand-treat areas that could not be reached by boat.

Treatment with antimycin would occur during late summer and fall because water flows are lowest in the fall, meaning less water is moving into and out of the lake. Because antimycin is not effective on salmonid eggs in stream habitats, it would also be beneficial to treat the lake before fish spawn, which occurs at different times of the year depending on the species. Hatchery fish usually spawn in the fall; some other fish spawn earlier (NPS, R. Zipp, pers. comm., 2003).

Trout exposed to lethal concentrations of antimycin gradually lose their fright response and dark coloration. Small trout (less than 12 inches in length) exposed to concentrations between 2 to 8 micrograms per liter (µg/L) for eight hours typically die within 24 hours. Larger trout can live longer but are usually approaching death within 48 hours. Larger fish with antimycin markings (that is, loss of dark coloration) often feed on smaller fish that have succumbed earlier in the treatment process (Rosenlund and Stevens 2002). Dead fish float either to the lake's surface or sink to the bottom. Crews would net the floating dead fish, puncture the fishes' air bladders, and sink the carcasses in deep areas of the lake (NPS, R. Zipp, pers. comm., 2003).

Careful monitoring using bioassay techniques would be used to ensure appropriate concentrations were being applied. Livecars (permeable cages) of fingerling rainbow trout would be placed in the lake and the outlet stream. The livecars in the lake would be monitored for fish mortality. The livecars in the outlet stream would be monitored to determine if detoxification of the outlet stream were needed. If mortality were documented, a 1 part per million concentration of potassium permanganate (an oxidizing agent that breaks down antimycin) would be dripped into the outlet stream. Livecars would be placed downstream of the potassium permanganate drip stations and monitored for at least 48 hours after treatment. The outlet stream would be considered detoxified if the fingerlings survived for more than 48 hours.

Bioassay:

A technique for determining the concentration or potency of a substance, such as a drug, by measuring its effect on a living organism.

The preferred method of detoxification would be to allow natural oxidation as elevation drops in the outlet stream. For lakes where passive detoxification would not be possible due to low-gradient outlet streams or other factors (for example, rare or sensitive taxa in the outlet stream), one of two active methods would be used to detoxify antimycin. The preferred method would be to temporarily dam the lake's outlet stream with plastic sheeting. This mitigation measure would temporarily prevent antimycin-tainted water from leaving the lake and allow detoxification in the lake. For lakes with outlet streams that could not be temporarily dammed, potassium permanganate drip stations would be placed in the outlet stream. However, natural oxidation of antimycin in the outlet stream would be preferred because potassium permanganate would cause long-term staining of the outlet stream (WDFW, B. Pfeifer, pers. comm., 2004). According to Morrison (1987), potassium permanganate has no adverse impacts on water quality or nontarget organisms. Lakes that would be candidates for fish removal

with antimycin would be larger than 5 acres in surface area and greater than 30 feet deep or would have an inlet or outlet stream that is habitable by fish.

Ideally, only one application of antimycin would be needed; however, repeat treatments could be required under certain unpredictable circumstances, such as incomplete mixing, water quality factors that reduce antimycin toxicity, short contact times due to high flows, or errors in calculating the volume of lake water due to an incomplete understanding of the actual depth of a lake (B. Rosenlund, pers. comm., 2003).

As an example of the treatment process, the steps for treating Lower Blum (West, No. 4) Lake are discussed. At 6.4 acres and 26 feet deep, the lake contains approximately 55 acre-feet of water. To achieve an effective dose concentration of at least 4 parts per billion, a minimum of 5.5 units of antimycin (2,640 cc or 88 oz.) would be required. The piscicide would be applied with a motorized lightweight boat that would be transported to the site via helicopter. The chemical would be dripped into the prop wash of the outboard motor to maximize mixing. Crews would also work along the lakeshore, treating shallow areas not effectively reached by boat. The outlet stream would be treated with a potassium permanganate solution to neutralize the antimycin and prevent impacts on nontarget species downstream. The application would take place in early August during low flows.

Brook trout would be removed from Lower Blum and Middle Blum lakes using a three-phased approach, including assessment (year 1), treatment (year 2), and follow-up (year 3). During the assessment phase, detailed physical, chemical, and biological data would be collected to improve the understanding of the abundance, diversity, and potential sensitivity of native aquatic species in the lake. Additional data about lake size and depth would be gathered to ensure antimycin calculations were correct. Data would also be gathered on the abundance and diversity of native aquatic species, and the data would then be used to evaluate the impacts of antimycin on those species. The lakes would be treated during the second year, with a possible follow-up treatment should the first treatment fail. Bioassays would monitor the progress and effectiveness of the treatment. The assays would involve placing cages of live fish (livecars) into the lake prior to the start of treatment, then monitoring mortality. Sampling with gillnets would also be used to determine the efficiency of the application.

During the third year, recovery of native organisms would be monitored. Longer-term monitoring would be incorporated into the North Cascades Complex's day-to-day resource management activities (NPS 2004). Refer to the "Management and Operations" section in the "Environmental Consequences" chapter.

FEASIBILITY OF FISH REMOVAL

The use of antimycin to remove reproducing fish populations is proposed as a management action common to the three action alternatives. The impact analysis for fish removal actions assumes that removal is possible and would be performed according to provisions of each management alternative (the impact analysis is provided in the "Environmental Consequences" chapter). Complete removal, however, may not be feasible for some lakes (refer to table 7). If it is determined that complete fish removal using antimycin is not possible, other methods of removal may need to be considered. A lake-specific NEPA analysis would be completed in the future if implementation of alternative fish removal methods were required.

Many factors govern the feasibility of successfully removing reproducing populations of fish. Table 8 provides some of the most important factors that must be considered before treating a lake with the piscicide antimycin (trade name Fintrol®) (Rosenlund and Stevens 2002). Lake-specific data are lacking for many of the factors presented in table 8, and since complete data are not available, lake size (surface area in acres) and an estimate of lake volume were used for a preliminary assessment of the feasibility of fish removal. Feasibility of fish removal was assumed to be low if lake surface area exceeds 50 acres or lake volume exceeds 1,000 acre-feet. Table 7 (presented earlier) identifies the nine lakes having characteristics that could make complete fish removal infeasible.

NATURAL TREATMENT METHODS

Lakes that would be candidates for the natural treatment method are those that contain only nonreproducing stocked fish. For lakes that contain only stocked fish that do not reproduce, the method of treatment may be as simple as ceasing stocking. The natural die-off of all remaining fish could take 7 to 10 years, or in exceptional cases, as long as 15 years (Nelson 1987). Water temperature is the biggest factor in determining the life span of a trout or char (Behnke 2002). Fish in lakes at higher elevations with shorter ice-free periods live longer; conversely, fish in lakes at lower elevations with longer ice-free periods do not live as long. Angling and predation also affect fish longevity, as does fish density, but to a lesser degree. Greater numbers of fish result in fewer food sources and a reduced life span (NPS, R. Zipp, pers. comm., 2003).

The initial decline in fish densities could be accelerated by providing incentives for anglers to catch and remove the fish, such as increased bag limits. For lakes where the rate of reproduction is very low and likely not to occur at all in some years, it may also be possible to use natural attrition to remove the fish over a period of years, especially if natural reproduction has been supplemented by stocking of nonreproducing fish. Table 9 identifies the lakes that are candidates for the natural treatment method under each action alternative. It is important to note that for this plan/EIS, the impact analysis of fish removal in the "Environmental Consequences" chapter assumes that natural treatment methods would be performed as indicated in this table.

TABLE 8: FACTORS THAT MAY AFFECT THE FEASIBILITY OF SUCCESSFULLY REMOVING REPRODUCING POPULATIONS OF FISH FROM LAKES

Factor	Description
Lake surface area	It takes more time to apply piscicide to larger lakes than smaller lakes. Rosenlund and Stevens (2002) recommend treatment rates not to exceed 2 hectares per hour (or 4.94 acres per hour). Large lakes might require multiple sets of treatment equipment and several crews to hasten application rates and maximize fish exposure to toxic concentrations of antimycin prior to its degradation. As lake size increases, it might be more difficult to thoroughly treat the lake surface, and this could result in uneven treatment and fish survival (treatment failure).
Lake volume	Accurate measurements of lake volume are needed in order to calculate quantities of antimycin required for treatment. Estimates of lake volumes are made using maximum depth and surface area data, and the assumption of a simple conical shape to the lake basin. As lake volume increases, the ability to evenly distribute antimycin in the water column decreases, especially in deeper areas. Incomplete mixing could prevent a complete fish kill and lead to treatment failure.
Residence time	Residence time is needed in order to estimate the contact time and dose concentration of antimycin required for effective treatment. It would be more feasible to treat lakes with long residence times because fish would have greater exposure to toxic concentrations of antimycin (that is, longer contact time).
Shoreline complexity	Lakes with highly irregular shorelines have a greater littoral zone (shoreline) surface area; therefore, more time is required to apply piscicide to shallow areas where fish can potentially escape lethal doses.
Bathymetric complexity	In lakes with irregularly shaped basin forms, it might be more difficult to apply piscicide thoroughly and evenly throughout the water column. Calculations assuming a simple conical shape would be less accurate, increasing the potential for incomplete treatment. All lakes greater than 5 acres in size should be surveyed and mapped for volume and bathymetry (the measurement of water depth at various places in a water body). Until these surveys are performed, a conical shape is assumed.
Woody/rocky debris	Large amounts of debris can create hiding areas for fish and can also increase application difficulties by hampering boat access.
Downstream/ upstream dispersal	Lakes connected by streams passable to fish should be treated concurrently, or not at all, if there is a potential for fish to recolonize the lakes.
Habitable inlet/outlet streams	Habitable inlet/outlet streams should be treated concurrently with the lake to prevent recolonization. Extensive inlet/outlet streams with no fish barriers would greatly limit feasibility of fish removal if these systems could not be treated adequately.
pH	Alkaline waters (pH exceeding 8.5) rapidly degrade antimycin and greatly limit toxicity by reducing lethal concentration contact time. Most lakes in the North Cascades Complex have a pH that is near the neutral level of 7.0.
Water temperature	Low temperatures reduce the toxicity of antimycin. Colder waters (less than 60°F) require longer treatment times or greater treatment concentrations.

TABLE 9: NATURAL TREATMENT METHODS FOR LAKES WITH NONREPRODUCING FISH

Lake Name	NPS Lake Code	Nonnative Trout Species	Proposed Fish Removal Methods		
			Alternative B	Alternative C	Alternative D
Bouck, Upper	DD-05-01	Rainbow	Natural	Natural	Natural
Bowan	MR-12-01	Rainbow	Natural	Natural	Natural
Coon	MM-10-01	Cutthroat	NA[a]	NA	Natural
Copper[b]	MC-06091	Rainbow, Cutthroat	Data needed[c]	Natural	Natural
Dee Dee/Tamarack, Lower	MR-15-02	Rainbow	Natural	Natural	Natural
Diobsud No. 3, Upper	LS-03-01	Rainbow	Natural	Natural	Natural
Hidden Lake Tarn	EP-14-01	Rainbow	Natural	Natural	Natural
Hi-Yu	M-0-01	Rainbow	Data needed	Natural	Natural
Kwahnesum	MC-07-01	Rainbow	Natural	Natural	Natural
Monogram Tarn	M-23-11	Cutthroat	Natural	Natural	Natural
Nert	M-05-01	Rainbow	Natural	Natural	Natural
No Name	PM-01-01	Rainbow	NA	Natural	Natural
Panther Potholes, Lower	RD-05-01	Cutthroat	Natural	Natural	Natural
Pond SE of Kettling Lakes	MR-09-01	Rainbow	NA	NA	Natural
Quill, Lower	M-24-02	Rainbow	Data needed	Natural	Natural
Quill, Upper	M-24-01	Rainbow	Data needed	Natural	Natural
Rainbow, Upper (South)	MR-13-02	Rainbow	Natural	Natural	Natural
Rainbow, Upper (West)	MM-11-01	Rainbow	Natural	Natural	Natural
Ridley	HM-03-01	Rainbow	NA	NA	Natural
Stiletto	MR-01-01	Rainbow	Data needed	Natural	Natural
Sweet Pea	ML-02-01	Rainbow	NA	Natural	Natural
Thornton, Middle	M-19-01	Rainbow	NA	Natural	Natural
Torment	ML-03-01	Rainbow	Natural	Natural	Natural
Triumph	M-17-01	Rainbow	NA	Natural	Natural
Unnamed	MR-11-01	Rainbow	NA	NA	Natural
Willow	HM-04-01	Cutthroat	NA	NA	Natural

Notes:

a. “NA” means that fish removal is not part of the overall management action for the respective alternative.

b. In August 2004, a large fish kill was observed in Copper Lake, possibly due to disease. Further surveys are needed to confirm that the lake is fishless.

c. “Data needed” means that the densities of reproducing fish are currently unknown, and more data are needed to determine whether fish densities are high enough to justify removal. If fish removal were deemed necessary where data are missing, treatment methods identified for the action alternatives would be implemented. At this time, it is envisioned that natural fish removal would be implemented.

ALTERNATIVE B

PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK

(42 LAKES MAY HAVE FISH)

(PREFERRED ALTERNATIVE)

GENERAL CONCEPT

Alternative B

- 29 lakes would have fish
- 49 lakes would be fishless
- 13 lakes would be evaluated for restocking

This alternative would conserve biological integrity in lakes by eliminating or reducing (if elimination proved infeasible) reproducing fish populations. Sport fishing would continue to be managed in lakes where the risks to biological integrity could be minimized through application of management principles described earlier in the section titled "Development of Management Actions for Alternatives B and C." A number of mountain lakes in the North Cascades Complex would be returned to their naturally fishless conditions using mechanical, chemical, and natural treatment methods of fish removal. It may not be feasible to remove reproducing populations of fish in the nine larger, deeper lakes identified in table 7, so these lakes would continue to provide residual sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved.

Select lakes would be stocked with low densities of fish incapable of reproduction in order to prevent reestablishment of self-sustaining populations. Stocked fish would be native to the basin or sterile to minimize the potential impacts of downstream dispersal (table 18 in the "Affected Environment" chapter provides more information on the fish that are considered native to the basin). The management actions described in table 4 would be applied to the 91 lakes as shown in table 5. For the current status and condition of the 91 lakes, refer to table 5 and appendix E.

As noted in the description of alternative A (existing management), 62 of the 91 lakes in the study area have fish, and the remaining 29 lakes are fishless. Under alternative B, 10 management actions would be available for a given lake depending on its current status and characteristics. These adaptive management actions, discussed earlier under "Adaptive Management" in the "Elements Common to All Action Alternatives" section, have been summarized into the management actions for alternative B as shown in table 10 and figure 6. For some lakes, monitoring may indicate the need for a change in management action. Ultimately, any lake that would contain fish from the initial implementation of this alternative could be considered for complete fish removal in the future based on the results of monitoring (see appendix F for details regarding monitoring).

TABLE 10: PROPOSED MANAGEMENT ACTIONS FOR ALTERNATIVE B

Management Action (number)[a]	Number of Lakes	
Lakes that would continue to have fish under alternative B[b,c]		
	Inside a national recreation area	Inside the national park
Continue to stock with nonreproducing fish (4C)	5	4
Remove reproducing fish, allow lake to rest, and restock with nonreproducing fish (2C)	3	8
Evaluate reproductive status of fish, allow low densities of fish (reproducing or nonreproducing) (3B)	1	6
Supplement the low densities of reproducing fish presently in the lake with stocked nonreproducing fish (3C)	0	2
Subtotal	**9**	**20**
Lakes that would become or be maintained fishless under alternative B		
	Inside a national recreation area	Inside the national park
Discontinue stocking of lake (nonreproducing) (4A)	5	7
Treat lakes to remove low-density reproducing fish (3A)	0	0
Treat lakes to remove high-density reproducing fish (2A)	2	6
Maintain as fishless (1)	3	26
Subtotal	**10**	**39**
Lakes to be evaluated prior to determining management action under alternative B		
	Inside a national recreation area	Inside the national park
Discontinue stocking lake, gather information, determine if lake should be restocked (4B)	0	5
Remove reproducing fish, gather information, determine if lake should be restocked (2B)	3	5
Subtotal	**3**	**10**
	Inside a national recreation area	Inside the national park
Grand Total	**22**	**69**

Notes:

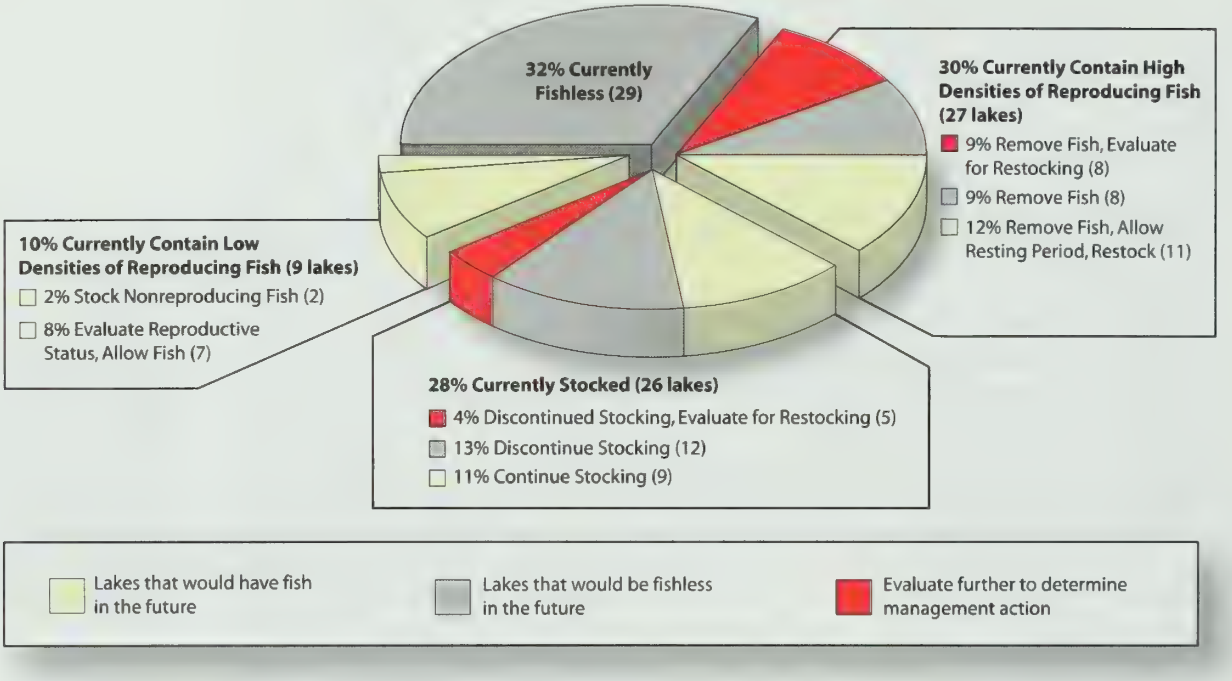
a. For a full description, see the "Management Actions" section and tables 4 and 5 in this chapter.

b. These lakes would continue to have fish based on the management action as first applied. For some, if monitoring indicates a problem, the availability may be reduced in the future.

c. The possible future outcome of alternative B would be that 42 lakes may have fish, which is the total of 29 lakes that would continue to have fish, combined with the 13 lakes that would be evaluated to determine if they should be restocked.

FIGURE 6: STATUS OF 91 LAKES UNDER ALTERNATIVE B

Under Alternative B, 32% of lakes in the study area (29 lakes) would have fish; 54% (49 lakes) would become fishless; 14% (13 lakes) would be evaluated for restocking. This means that a maximum of 42 lakes may have fish.



IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION

Under alternative B (as in alternative A), in order to continue stocking lakes in the North Cascades Complex, the NPS would seek congressional action to provide clarification of the enabling legislation for the North Cascades Complex. Refer to "Implementing the Fishery Management Plan through Congressional Action" in the description of alternative A that was presented earlier in this chapter. Congressional action to clarify its intent in the enabling legislation for the North Cascades Complex to allow for continued fish stocking would set a precedent for this NPS unit, and possibly others that have, or may have in the future, fish stocking issues.

MINIMUM REQUIREMENTS

Under alternative B, the NPS considers allowing stocking to continue in certain mountain lakes and also considers removing fish from certain mountain lakes through various treatment methods.

The results of the minimum requirements analysis show that removal of self-sustaining (reproducing) nonnative fish populations is necessary to help reestablish the historically fishless conditions of lakes in the Steven T. Mather Wilderness, and that stocking of nonnative fish to create and enhance an artificial recreational fishery is not necessary to meet the minimum requirements for the administration of the Stephen T. Mather Wilderness (see appendix K). This conclusion is based upon the well-documented impacts on ecosystem functions and values that result from introducing nonnative fish into mountain lake ecosystems that were historically fishless. Stocking naturally fishless lakes, even with nonreproducing trout, would not leave the wilderness "ideally free from human control or manipulation." Stocking of fish would manipulate the native ecology of a lake and introduce a nonnative species for the purpose of enhancing recreation.

Some, including the WDFW, disagree with the conclusions reached in the minimum requirements analysis. They maintain that recreational fishing is allowed under the *Wilderness Act*, and therefore, creating and enhancing fishing opportunities are appropriate actions in wilderness areas. Those who disagree with the conclusions reached in the minimum requirements analysis also believe that if nonnative fish were stocked appropriately, there would be no unacceptable adverse impacts on wilderness values because biological integrity would be conserved. For a detailed discussion of the minimum requirements process, refer to the alternative A section titled, "Minimum Requirements."

PROPOSED FISHERY MANAGEMENT PROGRAM

PROPOSED MANAGEMENT FRAMEWORK

The proposed management framework under alternative B would be to eliminate high densities of reproducing fish populations from lakes in the study area while allowing low densities of reproducing and nonreproducing fish populations. Management actions would be applied to the 91 study area lakes throughout the North Cascades Complex. The restocking of nonreproducing fish would be allowed only where impacts on biological resources could be minimized. Based on the best available science, some lakes could be restocked with low densities of nonreproducing fish once reproducing fish have been removed. Lakes where critical information is missing would not be stocked until that information becomes available. An extensive monitoring program (see appendix F) would be implemented to adjust future management and to avoid unacceptable effects on native biota from fish presence.

PROPOSED STOCKING PROGRAM

Fish stocking would only continue in lakes where biological integrity could be conserved according to the principles described in table 2. This would be accomplished by stocking with low densities of nonreproducing fish. The lakes that would be stocked under alternative B are shown in table 5. In determining which lakes to stock, the Technical Advisory Committee applied the information contained in tables 1–3, among other data, to develop the management actions described in table 4. From this information, the committee then applied a

management action to each of the 91 lakes under alternative B, as shown in table 5. Fish density (high/low) and fish status (reproducing/nonreproducing) were important factors in determining which lakes would be stocked (see appendix E). For example, some lakes with a high density of reproducing fish would have reproducing fish removed, and further information on the lake would be collected prior to considering the lakes for restocking with nonreproducing fish. Or, other lakes with a high density of reproducing fish would become fishless, if feasible, in order to allow native species to recover in a lake that is part of a series of lakes that currently contain fish.

Lakes that would continue to be stocked with no other constraints are identified by management action 4C. Some lakes would be restocked after fish removal (provided reproducing fish populations could be removed), and subsequent monitoring data indicated that the abundance and diversity of native organisms could be conserved. These lakes are identified by management action 2B. The lakes identified by management action 2C would be restocked following removal of reproducing fish populations and a resting period for recovery of native organisms. Stocking would be discontinued for some lakes that are currently stocked because there is not enough information to support continued stocking with the assurance that biological integrity would be conserved. These lakes would be evaluated in accordance with management action 4B (table 4 provides a description of the management actions).

Proposed Stocking Practices

Stocking practices would be the same as alternative A.

Proposed Species and Strains of Fish to be Stocked, Stocking Cycles, and Stocking Densities. The species and strains of fish to be stocked, stocking cycles, and proposed stocking densities are displayed in table 6. Based on monitoring and adaptive management, the following may change: species and strains of fish to be stocked, stocking cycles, and densities stocked. Any species of fish stocked in the future would be nonreproducing.

Specific Times of Year Proposed for Stocking. As in alternative A, the high-elevation lakes proposed for stocking under alternative B would be stocked during the ice-free period, which varies from year to year, but is generally between mid-July to mid-September. Stocking can start as early as May in lower-elevation lakes or as late as the end of October in higher-elevation lakes that ice-out later.

Proposed Stocking Methods. Lakes would be stocked either from the ground via backpack or from the air via fixed-wing aircraft. Whenever feasible, backpack stocking would be the preferred stocking method to minimize impacts on wilderness values. Under the backpack stocking method, WDFW personnel or approved volunteers would carry fry in plastic containers into the lake and release the fish by hand. Fixed-wing aircraft would be used for larger, remote lakes because it is difficult to keep fry alive in backpacks for extended periods, and lengthy travel times can increase fry mortality. The aircraft would be equipped with specialized chambers to carry fish. To ensure the correct lakes would be stocked, Global Positioning System (GPS) instrumentation and skilled, experienced personnel would be used to navigate to target lakes. Lakes would only be stocked under favorable weather conditions, and only lakes greater than 5 acres would be stocked by aircraft (WDFW 2001).

Under alternative B, at least 29 lakes would be backpack stocked, and as many as 12 lakes would be stocked with fixed-wing aircraft following a minimum tool evaluation. Table 11 shows the methods that would be used for stocking each lake under alternatives B and C and the methods currently used under alternative A.

PROPOSED LAKE TREATMENTS TO MANAGE THE FISHERY

The methods of removing fish are discussed above in the "Elements Common to All Action Alternatives" section. The proposed treatment methods to remove fish in specific lakes are given in tables 7 and 9.

PROPOSED MITIGATION

See appendix I for a description of proposed mitigation practices that would be used under this alternative to minimize potential impacts of fish stocking and lake treatment methods.

PROPOSED MONITORING PROGRAM

While priorities for monitoring and evaluation may change across alternatives, the basic monitoring program is common to all action alternatives. A description of the proposed monitoring program can be found in appendix F.

COST OF IMPLEMENTATION

The total costs of implementing alternative B are estimated to be $2.14 million over the next 15 years. The bulk of these costs would be associated with fish removal actions. For a detailed explanation of program costs under alternative B, see the "Management and Operations" section in the "Environmental Consequences" chapter.

Fixed-wing aircraft would be used to stock the larger, remote lakes.

TABLE 11: METHODS USED FOR TRANSPORTING FISH TO LAKES STOCKED UNDER ALTERNATIVES A, B, AND C

	Method Used to Transport Fry	Method that Would be Used to Transport Fry[a]	
Lake Name	**Alternative A**	**Alternative B**	**Alternative C**
Battalion	Backpack, fixed-wing aircraft	Backpack	Backpack
Berdeen	Fixed-wing aircraft	Fixed-wing aircraft	NA[b]
Blum (Lower/West No. 4)	Reproducing fish present[c]	Backpack	NA
Bear	Reproducing fish present[c]	Fixed-wing aircraft	NA
Blum (Largest/Middle, No. 3)	Backpack, fixed-wing aircraft; unknown	NA	NA
Bouck, Lower	Reproducing fish present[c]	Fixed-wing aircraft	Fixed-wing aircraft
Bouck, Upper	Backpack	NA	NA
Bowan	Backpack	NA	NA
Coon	Fixed-wing aircraft; unknown	Backpack or stock (e.g., horse)	Backpack or stock (e.g., horse)
Copper[d, e]	Fixed-wing aircraft; unknown	Backpack	NA
Dagger	Backpack	Backpack or stock (e.g., horse)	NA
Dee Dee, Upper	Backpack	Backpack	NA
Doubtful	Reproducing fish present[c]	Fixed-wing aircraft	NA
Diobsud No. 2	Backpack, fixed-wing aircraft	Backpack	NA
Diobsud No. 3, Upper	Backpack, fixed-wing aircraft; unknown	NA	NA
Doug's Tarn	Reproducing fish present[c]	Backpack	NA
Green	Reproducing fish present[c]	Fixed-wing aircraft	NA
Firn	Backpack, fixed-wing aircraft	NA	NA
Hidden	Backpack, fixed-wing aircraft; Unknown	Backpack or fixed-wing aircraft	NA
Hidden Lake Tarn	Backpack	NA	NA
Hozomeen	Fixed-wing aircraft	NA	NA
Hi-Yu[d]	Backpack, unknown	Backpack	NA
Jeanita	Backpack, unknown	NA	NA
Kwahnesum	Backpack, fixed-wing aircraft	NA	NA
McAlester	Fixed-wing aircraft	Backpack or stock (e.g., horse)	Backpack or stock (e.g., horse)
Monogram	Backpack, fixed-wing aircraft; unknown	Backpack or fixed-wing aircraft	NA
Nert	Backpack, unknown	NA	NA
No Name	Backpack, unknown	Backpack	NA
Panther Potholes (Lower)	Backpack, fixed-wing aircraft	NA	NA
Pond SE of Kettling Lakes	Backpack	Backpack	Backpack
Quill, Lower[d]	Backpack	Backpack	NA
Quill, Upper[d]	Backpack	Backpack	NA
Rainbow	Unknown	Backpack or stock (e.g., horse)	Backpack
Rainbow, Upper (West)	Backpack, fixed-wing aircraft	NA	NA

TABLE 11: METHODS USED FOR TRANSPORTING FISH TO LAKES STOCKED UNDER ALTERNATIVES A, B, AND C (CONTINUED)

	Method Used to Transport Fry	Method that Would be Used to Transport Fry[a]	
Lake Name	**Alternative A**	**Alternative B**	**Alternative C**
Rainbow, Upper, (South)	Backpack, fixed-wing aircraft; unknown	NA	NA
Ridley	Backpack	Backpack	Backpack
Skymo	Backpack, fixed-wing aircraft; unknown	Backpack or fixed-wing aircraft	NA
Sourdough	Fixed-wing aircraft; unknown	Fixed-wing aircraft	NA
Stiletto[d]	Backpack, fixed-wing aircraft	Backpack	NA
Stout	Backpack, unknown	NA	NA
Stout, Lower	Reproducing fish present[c]	NA	NA
Sweet Pea	Backpack, unknown	Backpack	NA
Thornton, Lower	Backpack, fixed-wing aircraft, unknown	Backpack or fixed-wing aircraft	NA
Thornton, Middle	Backpack, unknown	Backpack or fixed-wing aircraft	NA
Torment	Backpack	NA	NA
Trapper	Reproducing fish present[c]	Backpack or fixed-wing aircraft	NA
Triplet, Lower	Reproducing fish present[c]	Backpack	Backpack
Triplet, Upper	Reproducing fish present[c]	NA	NA
Triumph	Backpack	Backpack	NA
Unnamed (MR -11-01)	Backpack	Backpack	Backpack
Unnamed (MR-16-01)	Reproducing fish present[c]	NA	NA
Wilcox/Sandie, Lower	Reproducing fish present[c]	Backpack	NA
Willow	Backpack, fixed-wing aircraft, unknown	Backpack	Backpack

Notes:

The surface area and other details about the 91 lakes can be found in appendix E.

Stocking densities and cycles can be found in table 6 and appendix E.

a. The final determination of whether to transport fish to lakes using backpacks, stock (e.g., horses), or fixed-wing aircraft is a minimum tool-related issue that would be determined when the NPS completes the minimum tool analysis as part of the record of decision on this plan/EIS. Backpack or stock (e.g., horses) would be preferred over fixed-wing aircraft unless a lake were too large, remote, or otherwise inaccessible.

b. "NA" means the lake would not be available for stocking.

c. Reproducing fish present, but stocking has not occurred in the recent past.

d. The decision about continued stocking of these lakes is pending further data collection and evaluation.

e. In August 2004, a large fish kill was observed in Copper Lake, possibly due to disease. Further surveys are needed to confirm that the lake is fishless.

ALTERNATIVE C

PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

GENERAL CONCEPT

Alternative C applies a new management framework to the 22 lakes in the study area, wherein 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish, and 2 lakes would be evaluated for restocking. Of the other 11 lakes in the national recreation areas, 3 would remain fishless, 3 would have high-density reproducing fish removed, and stocking would be discontinued in 5 lakes. The remaining 69 lakes are in the national park portion of the North Cascades Complex and would be returned to their natural fishless condition or would remain fishless.

Alternative C

8 lakes would have fish
80 lakes would be fishless
3 lakes would be evaluated for restocking

While NPS policy states that in general, "exotic species will not be introduced into parks" (NPS 2001a, 4.4.3), policies also state:

> In some situations, the Park Service may stock native or exotic animals for recreational harvesting purposes, but only when such stocking will not impair park natural resources or processes, and:
>
> - The stocking is of fish into constructed large reservoirs or other significantly altered large water bodies and the purpose is to provide for recreational fishing; or
> - Such stocking is in a national recreation area or preserve that has historically been stocked (in these situations, stocking only of the same species may be continued); or
> - Congressional intent for stocking is expressed in statute or a House or Senate report accompanying a statute.
>
> The Service will not stock waters that are naturally barren of harvested aquatic species.

Within the national recreation areas, fish would remain in lakes where a low density of reproducing or nonreproducing fish populations would not have unacceptable effects on native biological resources. It may not be feasible to remove reproducing populations of fish in the 9 larger, deeper lakes identified in table 7 (1 of these is in a national recreation area), so these lakes would continue to provide residual sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved.

The adaptive management actions, discussed previously under "Adaptive Management" in the "Elements Common to All Action Alternatives" section, have been summarized for alternative C in table 12 and figure 7. For a listing of management actions by lake under alternative C, refer to table 5; for the current status and condition of the 91 lakes, refer to appendix E.

TABLE 12: PROPOSED MANAGEMENT ACTIONS FOR ALTERNATIVE C

Management Action (number)[a]	Number of Lakes	
Lakes that would continue to have fish under alternative C[b,c]		
	Inside a national recreation area	Inside the national park
Continue to stock with nonreproducing fish (4C)	5	0
Remove reproducing fish, allow lake to rest, and restock with nonreproducing fish (2C)	3	0
Evaluate reproductive status of fish, allow low densities of fish (reproducing or nonreproducing) (3B)	1	0
Supplement the low densities of reproducing fish presently in the lake with stocked nonreproducing fish (3C)	0	0
Subtotal	**9**	**0**
Lakes that would become or be maintained fishless under alternative C		
	Inside a national recreation area	Inside the national park
Discontinue stocking of lake (nonreproducing) (4A)	5	16
Treat lakes to remove low- density reproducing fish (3A)	0	8
Treat lakes to remove high-density reproducing fish (2A)	3	19
Maintain as fishless (1)	3	26
Subtotal	**11**	**69**
Lakes to be evaluated prior to determining management action under alternative C		
	Inside a national recreation area	Inside the national park
Discontinue stocking lake, gather information, determine if lake should be restocked (4B)	0	0
Remove reproducing fish, gather information, determine if lake should be restocked (2B)	2	0
Subtotal	**2**	**0**
	Inside a national recreation area	Inside the national park
Grand Total	**22**	**69**

Notes:

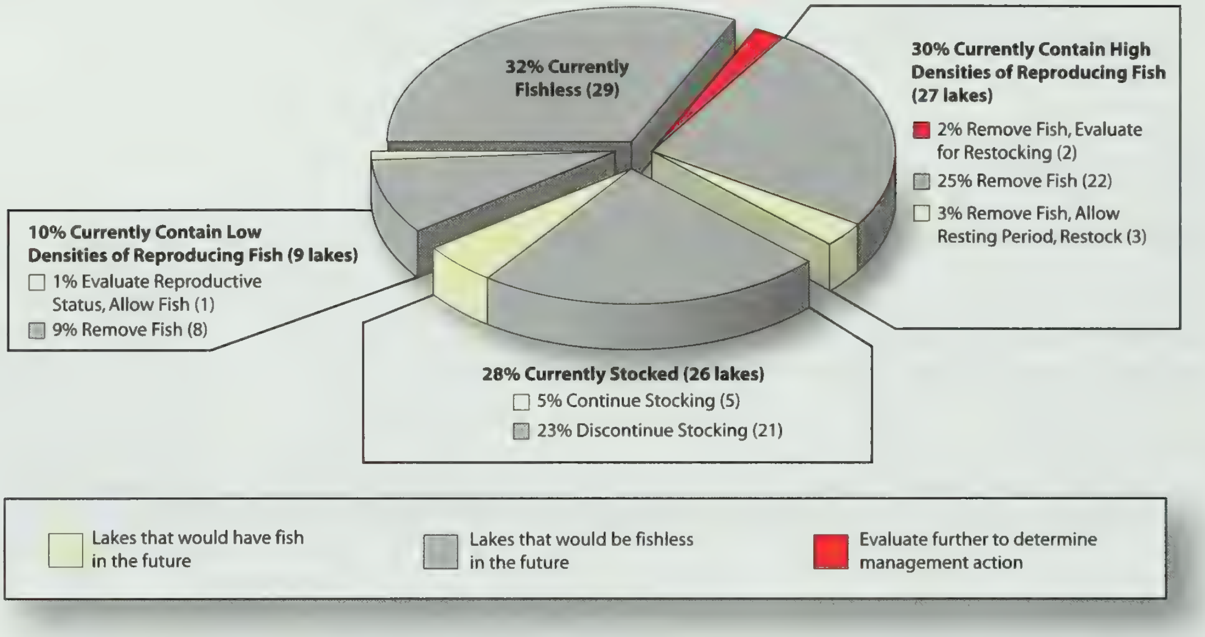
a. For a full description, see the "Management Actions" section and tables 4 and 5 in this chapter.

b. These lakes would have fish based on the management action as first applied. For some, if monitoring indicates a problem, the availability may be reduced in the future.

c. The possible future outcome of alternative C would be that 11 lakes may have fish, which is the total of 9 lakes that would continue to have fish, combined with the 2 lakes that would be evaluated to determine if they should be restocked.

FIGURE 7: STATUS OF 91 LAKES UNDER ALTERNATIVE C

Under Alternative C, 9% of lakes in the study area (9 lakes) would have fish; 89% (80 lakes) would become fishless; 2% (2 lakes) would be evaluated further. This means that a maximum of 11 lakes may have fish.



IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION

Under alternative C (as in alternatives A and B), in order to continue stocking lakes in the North Cascades Complex (only select national recreation area lakes would be stocked under alternative C), the NPS would seek congressional action to provide clarification of the enabling legislation for the North Cascades Complex. Refer to "Implementing the Fishery Management Plan through Congressional Action" in the description of alternative A that was presented earlier in this chapter. Congressional action to clarify the intent in the enabling legislation for the North Cascades Complex to allow for continued fish stocking would set a precedent for this NPS unit and possibly others that have, or may have in the future, fish stocking issues.

MINIMUM REQUIREMENTS

Under alternative C, the NPS considers allowing stocking to continue in certain mountain lakes and also considers removing fish from certain mountain lakes through various treatment methods.

The results of the minimum requirements analysis show that removal of self-sustaining (reproducing) nonnative populations of fish is necessary to help reestablish the historically fishless conditions of lakes in the Steven T. Mather Wilderness, and that stocking of nonnative fish to create and enhance an artificial recreational fishery is not necessary to meet the minimum requirements for the administration of the Stephen T. Mather Wilderness (see appendix K). This conclusion is based upon the well-documented impacts on ecosystem functions and values that result from introducing nonnative fish into mountain lake ecosystems that were historically fishless. Stocking naturally fishless lakes, even with nonreproducing trout, would not leave the wilderness "ideally free from human control or manipulation." Stocking of fish would manipulate the native ecology of a lake and introduce a nonnative species for the purpose of enhancing recreation.

Some, including the WDFW, disagree with the conclusions reached in the minimum requirements analysis. They maintain that recreational fishing is allowed under the *Wilderness Act*, and therefore, creating and enhancing fishing opportunities is an appropriate action in wilderness areas. Those who disagree with the conclusions reached in the minimum requirements analysis also believe that if nonnative fish were stocked appropriately, there would be no unacceptable adverse impacts on wilderness values because biological integrity would be conserved. For a detailed discussion of the minimum requirements process, refer to the alternative A section titled, "Minimum Requirements."

PROPOSED FISHERY MANAGEMENT PROGRAM

PROPOSED MANAGEMENT FRAMEWORK

The proposed management framework under alternative C would be to eliminate or reduce reproducing fish from lakes in the national recreation areas because high densities of reproducing fish populations can alter the lake ecosystem and negatively effect native biota. Restocking of nonreproducing fish would be allowed only where biological resources could be protected in lakes located in the national recreation areas. Based on best available science, some lakes could be restocked with nonreproducing fish at low densities once reproducing fish have been removed. Where critical information is missing, lakes would not be stocked until such information becomes available. A monitoring program (see appendix F) would be incorporated to adjust future management actions in order to avoid unacceptable effects on native biota from fish presence. The remaining 69 lakes in the national park portion of the North Cascades Complex either would remain fishless or become fishless.

PROPOSED STOCKING PROGRAM

The proposed stocking program under alternative C would differ from alternative B in that only lakes in the national recreation areas would be eligible for stocking. No lakes in the national park would be stocked. The lakes that would be stocked under alternative C are shown in table 5. As with alternative B, the Technical Advisory Committee determined which lakes to stock by applying the information contained in tables 1–3, among other data, to develop the management actions described in table 4. From this information, the committee then applied a management action to each of the 91 lakes under alternative C, as shown in table 5.

Fish density (high/low) and fish status (reproducing/nonreproducing) were important factors in determining which lakes would be stocked (refer to table 5 and appendix E). For example, Hozomeen and Upper Triplet lakes contain high densities of reproducing fish. Under alternative C, the 2 lakes would become fishless in order to allow native species to recover in a lake that is part of a series of lakes where some would contain fish. In 2 other lakes, the high-density reproducing fish would be removed, and further information on the lake would be collected prior to considering the lake for restocking of nonreproducing fish.

The 3 lakes in the national recreation areas that are currently fishless would remain fishless in order to allow these lakes to revert to pre-stocking conditions and/or maintain natural communities without influence from fish. The 26 lakes in the national park that are currently fishless would also remain fishless.

Management of Lakes in the National Park

There are 69 lakes in the national park; of these 69 lakes, 26 that are currently fishless would remain fishless, 16 lakes that are currently stocked would cease to be stocked, and 27 lakes would be treated to remove reproducing fish.

Proposed Stocking Practices

Stocking practices would be the same as alternative A.

Proposed Species and Strains of Fish to be Stocked, Stocking Cycles, and Densities. The species and strains of fish to be stocked, stocking cycles, and proposed stocking densities are displayed in table 6. Based on monitoring and adaptive management, the following may change: species and strains of fish to be stocked and stocking cycles and densities. Any species of fish stocked in the future would be nonreproducing.

Specific Times of Year Proposed for Stocking. As in alternative A, the mountain lakes proposed for stocking under alternative C would be stocked during the ice-free period, which varies from year to year, but is generally between mid-July to mid-September. Stocking can start as early as May in lower-elevation lakes or as late as the end of October in higher-elevation lakes that ice-out later.

Stocking Methods. Under alternative C, 9 lakes would be stocked via backpacks, and 1 lake would be stocked via fixed-wing aircraft following a minimum-tool evaluation. Table 11 shows the methods that would be used for stocking each lake under alternatives B and C and the methods currently used under alternative A.

PROPOSED LAKE TREATMENTS TO MANAGE THE FISHERY

Under alternative C, of the 22 lakes located in the national recreation areas, fish would be removed from 15 lakes. Some of these 15 lakes would be candidates for restocking, and some would remain fishless. Of the remaining 69 lakes located in the national park, 43 lakes would be actively managed to return to a fishless condition, and 26 lakes would be maintained in their fishless state. The methods of removing fish are discussed above in the "Elements Common to All Action Alternatives" section. The treatment methods proposed for specific lakes are given in tables 7 and 9.

PROPOSED MITIGATION

See appendix I for a description of proposed mitigation practices that would be used under this alternative to minimize potential impacts of fish stocking and lake treatment methods.

PROPOSED MONITORING PROGRAM

While priorities for monitoring and evaluation may change across alternatives, the basic monitoring program is common to all action alternatives. A description of the proposed monitoring program can be found in appendix F.

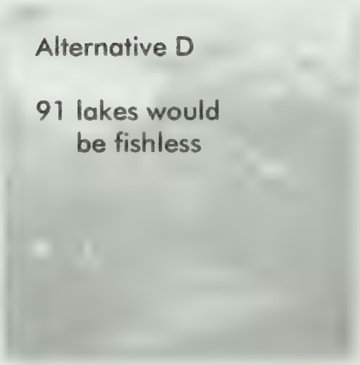
COST OF IMPLEMENTATION

The total costs of implementing alternative C are estimated at $2.84 million over the next 15 years. The bulk of these costs would be associated with fish removal actions. For a detailed explanation of program costs under alternative C, see the "Management and Operations" section in the "Environmental Consequences" chapter.

ALTERNATIVE D

91 LAKES WOULD BE FISHLESS (ENVIRONMENTALLY PREFERRED ALTERNATIVE)

GENERAL CONCEPT


Alternative D

91 lakes would be fishless

Alternative D represents 91 lakes in the North Cascades Complex that currently have fish as a result of either a documented or an undocumented history of fish stocking, in addition to those lakes that are currently fishless. The emphasis of this alternative would be to eliminate all fish from mountain lakes in the study area. For the current status and condition of the 91 lakes, see table 5 and appendix E.

Currently, 62 of the 91 study area lakes have fish and 29 are fishless. Under alternative D, four management actions would be available for a given lake. These management actions, discussed previously in the "Management Actions" section of this chapter, have been summarized in table 13.

TABLE 13: PROPOSED MANAGEMENT ACTIONS FOR ALTERNATIVE D

Management Action (number)*	Number of Lakes
Lakes become fishless or be maintained fishless under alternative D	
Discontinue stocking (nonreproducing) (4A)	26
Treat lakes to remove low-density reproducing fish (3A)	9
Treat lakes to remove high-density reproducing fish (2A)	27
Maintain as fishless (1)	29
Grand Total	**91**

Note:

* For a full description, see the "Management Actions" section in this chapter.

IMPLEMENTING THE FISHERY MANAGEMENT PLAN THROUGH CONGRESSIONAL ACTION

This alternative would not require congressional action to clarify the North Cascades Complex's enabling legislation.

MINIMUM REQUIREMENTS

Under alternative D, the NPS considers discontinuing stocking and removing fish from certain mountain lakes through various methods. The results of the minimum requirements analysis show that removal of self-sustaining (reproducing) nonnative populations of fish is necessary to help reestablish the historically fishless conditions of lakes in the Steven T. Mather Wilderness (see appendix K). For a detailed discussion of the minimum requirements process, refer to the alternative A section titled, "Minimum Requirements."

PROPOSED FISHERY MANAGEMENT PROGRAM

PROPOSED MANAGEMENT FRAMEWORK

The goal for alternative D is that all 91 study area lakes would be fishless: 29 currently fishless lakes would remain fishless and 62 would be returned to a fishless condition. Stocking would be discontinued in all lakes currently stocked and the stocked fish would die off within several years. After five years, the quality of sport-fishing opportunities in most of these lakes may decline due to fish mortality and removal from angling pressure (WDFW, M. Downen, pers. comm., 2004). Reproducing populations of fish would be gradually removed over time. The rate of removal would depend upon the availability of resources (funding and personnel) and differences among methods of removal. It may not be feasible to remove reproducing populations of fish in the nine larger, deeper lakes identified in table 7, so these lakes would continue to provide residual sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved.

Alternative D is most closely aligned with the current *NPS Management Policies* (NPS 2001a, 4.4.4.1), which state that, in general, "exotic species will not be introduced into parks." The NPS is instructed to not intervene in natural biological or physical processes, except in emergency situations to restore natural ecosystem functioning that has been disrupted by past human activities, when specifically directed by Congress, or when a park plan has identified the intervention as necessary to protect other park resources (NPS 2001a, 4.1). Section 4.1.5 of *NPS Management Policies* states: "[t]he Service will re-establish natural functions and processes in human-disturbed components of natural systems in parks unless otherwise directed by Congress," and "Impacts to natural systems resulting from human disturbances include the introduction of exotic species." The *NPS Management Policies*, section 6.3.7, Natural Resources Management in Wilderness, states:

> The principle of non-degradation will be applied to wilderness management, and each wilderness area's condition will be measured and assessed against its own unimpaired standard. Natural processes will be allowed, insofar as possible, to shape and control wilderness ecosystems. Management should seek to sustain the natural distribution, numbers, population composition, and interaction of indigenous species. Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and influences originating outside of wilderness boundaries.

Alternative D was crafted to meet the spirit and intent of *NPS Management Policies* by discontinuing stocking and eventually removing reproducing fish populations from mountain lakes wherever feasible. Alternative D also provides a basis for comparing the effects of the no-action alternative (alternative A) and the other action alternatives.

PROPOSED STOCKING PROGRAM

The intent of this alternative is that all mountain lakes in the national park and national recreation areas would eventually be fishless. To accomplish this, stocking would no longer occur in any of the lakes in the North Cascades Complex, and reproducing populations of fish would be systematically removed wherever feasible (see tables 7 and 9).

Proposed Stocking Practices

No fish would be stocked in lakes in the study area.

Proposed Species and Strains of Fish to be Stocked, Stocking Cycles, and Densities. No fish would be stocked in lakes in the study area.

Specific Times of Year Proposed for Stocking. No fish would be stocked in lakes in the study area.

Proposed Stocking Methods. No fish would be stocked in lakes in the study area.

PROPOSED LAKE TREATMENTS TO MANAGE THE FISHERY

Under alternative D, fish would be removed from 62 of the 91 lakes in the study area, and the 29 lakes that are currently fishless would remain fishless. The methods of removing fish are discussed above in “Elements Common to All Action Alternatives.” The treatment methods proposed for specific lakes are given in tables 7 and 9.

The long-term result would be that no mountain lakes would contain fish once all lakes were treated to remove reproducing fish populations; however, until lakes were treated, reproducing fish populations would persist. In spite of the goal of making all lakes fishless, complete removal might not prove feasible, especially from some of the larger, deeper lakes in the study area.

PROPOSED MITIGATION

See appendix I for a description of proposed mitigation practices that would be used under this alternative to minimize potential impacts of lake treatment methods.

PROPOSED MONITORING PROGRAM

While priorities for monitoring and evaluation may change across alternatives, the basic monitoring program is common to all action alternatives. A description of the proposed monitoring program can be found in appendix F.

Cost of Implementation

The costs of implementing alternative D are estimated to be $3 million over the next 15 years and potentially longer depending on feasibility of complete removal and funding availability. For a detailed explanation of program costs under alternative D, see the "Management and Operations" section in the "Environmental Consequences" chapter.

HOW ALTERNATIVES MEET OBJECTIVES

As stated in the "Purpose of and Need for Action" chapter, all action alternatives selected for analysis must meet all objectives to a large degree. The action alternatives must also address the stated purpose of taking action and resolve the need for action; therefore, the alternatives, and the effects they would have on the lakes in the study area, were individually assessed in light of how well they would meet the objectives for this plan/EIS. Alternatives that did not meet the plan/EIS objectives were not analyzed further (see the "Alternatives Eliminated from Further Consideration" section in this chapter).

The plan's objectives are to

> Obtain support from interested parties and groups to implement a new management plan for mountain lakes in the North Cascades Complex should the governing agencies decide a new plan is needed.
>
> Advance the protection and rehabilitation of native biological integrity by maintaining native species abundance, viability, and sustainability.
>
> Provide a spectrum of recreational opportunities, including sport fishing, while minimizing impacts to the biological integrity of natural mountain lakes.
>
> Apply science and research in decision-making at multiple spatial scales that include landscape, watershed, lake cluster, and individual lakes.
>
> Provide to the public and interested parties full and open access to available information.

While each action alternative seeks to protect the biological resources of the lakes in the study area, each action alternative would also provide varying degrees of recreational opportunities, including sport fishing. Even alternative D (91 Lakes Would Be Fishless) would provide sport-fishing opportunities in mountain lakes for a lengthy period because it would take many years to remove all reproducing fish populations from the mountain lakes. If it is not feasible to completely remove fish from larger, deeper lakes, fish densities would be reduced, and these lakes could provide sport-fishing opportunities indefinitely (refer to tables 7 and 8).

Table 14 summarizes the elements of the alternatives being considered. The "Environmental Consequences" chapter describes the effects on each impact topic under each of the alternatives, including the impact on recreational values and visitor experience. These impacts are summarized in "Table 15: Summary of Environmental Consequences." "Table 16: Analysis of How the Alternatives Meet Objectives," compares how each of the alternatives described in this chapter would meet the objectives for this plan/EIS. (Tables 14, 15, and 16 are located at the end of this chapter.)

Ridley Lake

Berdeen Lake
(south end)

Berdeen Lake
(from the outlet)

Skymo Lake

ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

The four alternatives described below were eliminated from further consideration.

Cease stocking in all lakes or in a portion of the lakes in the study area, but do not actively return lakes with reproducing fish to fishless conditions. Based on clear conclusions in reports from the U.S. Geological Survey (refer to the "Purpose of and Need for Action" chapter), high densities of fish often caused by uncontrolled reproducing fish populations were recognized as having the greatest adverse impacts on the native biota and ecosystems of mountain lakes in the North Cascades Complex. Consequently, this alternative was not deemed reasonable or selectable as an alternative and was not carried through full impact analysis.

Cease stocking in all or a portion of the lakes in the study area and return lakes to fishless conditions using solely passive methods (that is, natural lake treatment as defined in this plan/EIS). With the understanding that passive methods of removing fish from lakes could take many years, it was recognized that more expedient methods of fish removal would be desired in many cases due to the potential of ongoing, long-term adverse impacts on the native biota and ecosystems of mountain lakes in the North Cascades Complex.

Use biological treatment methods to remove fish from lakes. The use of biological controls using a sterile "apex" predator to remove fish from lakes as an element of an alternative was considered but rejected. Biological controls, such as the tiger muskellunge, were rejected because of a lack of case studies demonstrating success and because of the concern for unintended consequences to native species, including predation on nontarget organisms such as macroinvertebrates.

Provide sport fishing opportunities by stocking some of the 154 mountain lakes that have never had any fish presence. The 1985 Memorandum of Understanding between the NPS and WDFW was entered into in order to resolve differences in policy regarding fish stocking between the two agencies. The 1988 Supplemental Agreement to the Memorandum of Understanding identified as appropriate for fish stocking, 40 lakes in the national park that either have a history of fish stocking or have reproducing fish populations. This plan/EIS focuses on those 40 lakes, and the other 51 mountain lakes in the North Cascades Complex that have a history of fish presence; 29 of the 91 lakes are currently fishless. This plan/EIS did not contemplate stocking any of the 29 currently fishless lakes because both the NPS and WDFW assumed that if the lakes have gone fishless, they are undergoing a natural recovery process that should not be interfered with. The 154 mountain lakes in the North Cascades Complex have never had a presence of fish, and neither the NPS nor the WDFW advocate stocking any of those lakes. Consequently, an alternative that considered stocking currently fishless lakes outside of the 91 was not deemed a reasonable alternative.

CONSISTENCY WITH SECTIONS 101(B) AND 102(1) OF THE NATIONAL ENVIRONMENTAL POLICY ACT

The NPS requirements for implementing NEPA include an analysis of how each alternative meets or achieves the purposes of NEPA, as stated in sections 101(b) and 102(1). Each alternative analyzed in a NEPA document must be assessed as to how it meets the following purposes:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
2. Ensure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
3. Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
4. Preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
5. Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Council on Environmental Quality Regulation 1500.2 establishes policy for federal agencies' implementation of NEPA. Federal agencies shall, to the fullest extent possible, interpret and administer the policies, regulations, and public laws of the United States in accordance with the policies set forth in NEPA (sections 101(b) and 102(1)); therefore, other acts and NPS policies are referenced as applicable in the following discussion. In addition, *NPS Management Policies* address the application of NEPA to wilderness planning (NPS 2001a, 6.3.4.3).

Alternative A—No Action, Existing Management Framework of 91 Lakes (62 Lakes Have Fish). This alternative partially meets the purposes because it currently provides for angling, a recreational use in the North Cascades Complex for approximately 1,000 mountain lake anglers per year (see "Methodology and Assumptions" in the "Visitor Use and Experience" section in the "Environmental Consequences" chapter). The stocking of fish in the mountain lakes is considered, by some, to be a renewable resource that provides a beneficial use for a portion of visitors to the North Cascades Complex. This use is highly treasured by the angling community, especially in light of the history of the fishery and its

potential value to future generations. Alternative A does, however, involve continued risk and some unintended and undesirable consequences to the environment. As discussed in the "Environmental Consequences" chapter, alternative A would continue to cause impacts on native aquatic organisms, threatened and endangered species, sensitive vegetation, and wilderness values. These impacts are primarily associated with the current fishery management program that allows for continued existence of reproducing fish in naturally fishless lakes.

Alternative B, Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish), Preferred Alternative. This alternative meets the purposes overall, to some degree, and only partially meets purpose four with respect to preserving a cultural aspect of our heritage (high-lakes fishing) and with respect to individual choice. Some lakes would be available for fishing opportunities and some lakes would not, hence precluding opportunities and individual choice for some anglers. Alternative B would achieve a balance between population and resource use because it includes an adaptive management component (see the description of adaptive management in the "Elements Common to All Action Alternatives" section in this chapter). As discussed in the "Environmental Consequences" chapter, alternative B proposes to conserve biological integrity in lakes by eliminating or reducing reproducing fish populations. Elimination of reproducing fish populations would entail using various mechanical and chemical lake treatment methods, which may have unintended consequences; therefore, a small number of lakes would be treated and monitored in order to adjust the applied fish removal methods, if necessary. Select lakes would be stocked with low densities of fish that would not be capable of reproduction in order to prevent reestablishment of reproducing populations. Stocked fish would be native to the basin or incapable of reproduction to minimize potential downstream impacts. With these measures, alternative B meets the first purpose to a large degree; that is, it fulfills the responsibilities of each generation as trustee of the environment for succeeding generations given that fish stocking would only occur when long-term impacts on the environment could be avoided or minimized. However, because alternative B proposes to continue a fish stocking program in naturally fishless lakes in the North Cascades Complex, it is not totally consistent with *NPS Management Policies* (NPS 2001a), which seek to preserve native biota and conserve biological integrity. Alternative B may also be viewed by some as inconsistent with the *Wilderness Act* because it continues a practice of fish stocking and human influence in a designated wilderness area.

Alternative C, Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish). This alternative meets all six purposes to some degree and only partially meets purpose four with respect to preserving a cultural aspect of our heritage (high-lakes fishing) and with respect to individual choice. Some lakes in the national recreation areas would be available for fishing and some lakes would not, hence precluding opportunities and individual choice for some anglers. Nine lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish, and 2 lakes would be evaluated for restocking. Of the other 11 lakes in the national recreation areas, 3 would remain fishless, 3 would have high-density reproducing fish removed, and stocking would be discontinued in 5 lakes. The remaining

69 lakes are in the national park portion of the North Cascades Complex and would be returned to their natural fishless condition or would remain fishless. Similar to alternative B, some angling opportunities would be available but only in the mountain lakes located in the two national recreation areas. Alternative C would meet purpose four to a large degree because it would preserve important resources in the North Cascades Complex by returning a select number of mountain lakes to a fishless condition while maintaining a diversity of visitor experiences and variety of individual choices. With adaptive management practices applied to the lakes in the two national recreation areas, stocking would be allowed only if long-term impacts on the environment could be avoided or minimized. Some still may view fish stocking in the national recreation areas to be inconsistent with *NPS Management Policies* and the *Wilderness Act* because some of those lakes were naturally fishless, and human influences would continue in the Stephen T. Mather Wilderness.

Alternative D (91 Lakes Would be Fishless). This alternative meets the stated purposes of NEPA sections 101(b) and 102(1) to a large degree. This alternative only partially meets purpose four with respect to preserving a cultural aspect of our heritage (high-lakes fishing) and with respect to individual choice. Some lakes would be available for fishing in the short term and some lakes would not, hence precluding opportunities and individual choice for some anglers. The intent of this alternative is that all mountain lakes in the national park and national recreation areas would eventually be fishless, although nine lakes have been identified where complete fish removal may not be feasible (see table 7). Alternative D also applies adaptive management practices to return lakes to a fishless condition, thus restoring natural processes and conserving biological integrity over the long term. Alternative D would eliminate angling in those lakes with reproducing fish populations, currently stocked lakes, or lakes proposed to be stocked under alternatives B and C; therefore, it does eliminate individual choice for those who value this experience in the national park and two national recreation areas. There would, however, still be fishing opportunities in the reservoirs and streams. After five years, the quality of sport-fishing opportunities in most of the 91 study area lakes may decline due to fish mortality and removal from angling pressure (WDFW, M. Downen, pers. comm., 2004). The rate of removal would depend on resource (funding and personnel) availability and differences among fish removal methods. Complete removal of reproducing fish populations might not be feasible in the nine larger, deeper lakes identified in table 7, and as a result, biological integrity may still be compromised to some degree. These lakes would continue to provide sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved. There would be short-term consequences of this alternative because it proposes the use of mechanical and chemical methods to remove reproducing fish in a large number of lakes, which could involve impacts and unintended consequences. Treating a small number of lakes and adapting fish removal methods could avoid or minimize these consequences over the long term. Alternative D best meets the intent of *NPS Management Policies* in that it returns lakes to their naturally fishless condition, thereby conserving native biota and ecological processes. Some may also view this alternative as best meeting the requirements of the *Wilderness Act* in that, after returning lakes to a naturally fishless condition, human influences of fish stocking would be eliminated. However, illegal stocking may occur under this alternative.

ENVIRONMENTALLY PREFERRED ALTERNATIVE

The NPS is required to identify the environmentally preferred alternative in its NEPA documents for public review and comment. The NPS, in accordance with the Department of the Interior policies contained in the Department Manual (516 DM 4.10) and the Council on Environmental Quality's Forty Questions, defines the environmentally preferred alternative (or alternatives) as the alternative that best promotes the national environmental policy expressed in NEPA (Section 101(b)) (516 DM 4.10). The Council on Environmental Quality's Forty Questions (Q6a) further clarifies the identification of the environmentally preferred alternative stating, "simply put, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and native processes." Alternative D (91 Lakes Would Be Fishless) best protects the biological and physical environment by eliminating the consequences of stocked and reproducing fish populations over the long term. It is acknowledged, however, that angling in the mountain lakes has been a long-standing historic and cultural practice that would be eliminated through implementation of alternative D. The WDFW does not agree that alternative D is the environmentally preferred alternative because it does not strike any balance between protecting biological integrity and preserving historic processes.

TABLE 14: ALTERNATIVES ELEMENTS SUMMARY

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless
General Concept				
Lake management	No change in the way the North Cascades Complex fishery is managed. Lakes that are currently stocked would continue to be stocked, lakes with reproducing fish would be allowed to maintain reproducing fish, and all lakes without fish would continue to be fishless.	Manage 91 lakes in the study area that have a fish history from either a documented or undocumented history of fish stocking; the 91 lakes would be managed under a new adaptive management framework, which includes taking action to remove fish from select lakes.	Manage 91 lakes in the study area that have a fish presence from either a documented or undocumented history of fish stocking. 22 lakes are in the two national recreation areas (NRA) would be managed under a new adaptive management framework, which includes taking action to remove fish from some lakes (11 of the 22 NRA lakes may continue to have fish). 69 lakes in the national park either would remain fishless or be returned to fishless conditions.	The 91 lakes in the study area that have a history of fish presence from either documented or undocumented fish stocking would all become fishless over time, and stocking would be eliminated.
Current and Proposed Management				
Current and proposed management for fishless lakes	**Current Management** 29 lakes in the study area are currently fishless, including 3 in the national recreation areas and 26 in the national park.	**Proposed Management** 49 lakes in the study area would remain fishless or be actively returned to fishless conditions.	**Proposed Management** 80 lakes in the study area would remain fishless or be actively returned to fishless conditions; this includes 11 lakes in the national recreation areas and 69 lakes in the national park.	**Proposed Management** 91 lakes in the study area would remain fishless or be actively returned to fishless conditions.
Current and proposed management of lakes with high densities of reproducing fish	**Current Management** 27 lakes currently contain high densities of reproducing fish.	**Proposed Management** No lakes would contain high densities of reproducing fish.	**Proposed Management** No lakes would contain high densities of reproducing fish.	**Proposed Management** No lakes would contain high densities of reproducing fish.

TABLE 14: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless
Current and Proposed Management (continued)				
Current and proposed management of lakes with low-densities of fish (reproducing and nonreproducing)	**Current Management** 9 lakes currently contain low densities of reproducing fish.	**Proposed Management** 7 lakes would contain low densities of reproducing fish.	**Proposed Management** 1 lake in a national recreation area and no lakes in the national park would contain low densities of reproducing fish.	**Proposed Management** No lakes would contain low densities of reproducing fish.
Current and proposed management of lakes with nonreproducing fish	**Current Management** 26 lakes are currently stocked with nonreproducing fish.	**Proposed Management** 22 lakes would have nonreproducing fish.	**Proposed Management** 8 lakes in the national recreation areas would have nonreproducing fish. No lakes in the national park would be stocked.	**Proposed Management** No lakes would have fish.
Current and proposed management of lakes lacking data	**Current Management** No additional data would be needed to make final management action determinations.	**Proposed Management** 13 lakes would be evaluated under a new adaptive management framework prior to determining management action.	**Proposed Management** 2 lakes in the national recreation areas would be evaluated under a new adaptive management framework prior to determining management action.	**Proposed Management** No additional data would be needed to make final management action determinations.
Outcome of continuing current management framework shown above or implementing proposed new adaptive management framework	**Current Management Outcome** Of the 91 lakes in the study area, **62** would continue to have fish **29** would remain fishless.	**Possible Future Outcome** Of the 91 lakes in the study area, **29** lakes would have fish **49** lakes would be fishless **13** lakes would be evaluated before determining management action.	**Possible Future Outcome** Of the 91 lakes in the study area, **9** lakes would have fish **80** lakes would be fishless **2** lakes would be evaluated before determining management action.	**Possible Future Outcome** Of the 91 lakes in the study area, **91** lakes would either remain fishless or become fishless over time
Implementation	The NPS would seek clarification from Congress as to whether stocking should be an accepted practice in the North Cascades Complex.	Same as alternative A.	Same as alternative A.	No congressional action would be necessary.

TABLE 14: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless
Current and Proposed Management (continued)				
Consistency with *NPS Management Policies* (NPS 2001a)	This alternative is not consistent with existing *NPS Management Policies* regarding fish stocking and the introduction of exotic species.	This alternative is not consistent with existing *NPS Management Policies* regarding fish stocking and the introduction of exotic species.	This alternative is consistent with existing *NPS Management Policies* regarding fish stocking and the introduction of exotic species into national recreation areas lakes.	This alternative is consistent with existing *NPS Management Policies* regarding fish stocking and the introduction of exotic species.
Fish species (and strains) stocked (under alternative A) or fish species (and strains) proposed to be stocked under alternatives B and C	• Golden Trout • Coastal Cutthroat Trout (Lake Whatcom Strain) • Rainbow Trout (Mt. Whitney Strain) • Rainbow Trout (Ross Lake Strain) • Westslope cutthroat trout (twin Lakes Strain	• Rainbow Trout (Mt. Whitney Strain) • Rainbow Trout (Ross Lake Strain) • Golden Trout	• Rainbow Trout (Mt. Whitney Strain)	No lakes would be stocked.
Current and proposed reproducing fish species (and strains) to be maintained under alternatives A, B, and C	• Rainbow Trout (Packwood Lane Strain) • Westslope Cutthroat Trout (Twin Lakes Strain) • Brook Trout • Coastal cutthroat Trout (Lake Whatcom Strain) • Yellowstone Cutthroat Trout	• Rainbow Trout (Strain unknown) • Westslope Cutthroat Trout (Strain unknown) • Golden Trout • Westslope Cutthroat Trout (Twin Lakes Strain) • Yellowstone Cutthroat Trout	• Westslope cutthroat trout (Twin Lakes Strain) • Westslope cutthroat (Unknown Strain)	Two lakes potentially would contain reproducing fish populations: • Westslope cutthroat trout (Twin Lakes Strain) • Westslope cutthroat (Unknown Strain)

TABLE 14: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless
Current and Proposed Management (continued)				
Fish hatchery locations	• Arlington Hatchery, Washington • Eells Springs Hatchery, Washington • Marblemount Hatchery, Washington • WDFW Bellingham Hatchery, Washington • WDFW Chelan Hatchery, Washington	Same as alternative A.	Same as alternative A.	No lakes would be stocked.
Stocking density	Stocking density varies from year to year; see table 6 for stocking density of the most recent stocking efforts.	Same as alternative A.	Same as alternative A.	No lakes would be stocked.
Specific times of year for stocking	Stocking occurs during the ice-free period, which varies from year to year, but on average is between mid-July to mid-September; stocking can occur as early as mid-May or as late as mid-October depending on weather conditions.	Same as alternative A.	Same as alternative A.	No lakes would be stocked.
Stocking methods (and performed by whom)	Fixed-wing aircraft (by WDFW). Backpack (by WDFW and volunteers from Trail Blazers, Inc.).	Same as alternative A.	Same as alternative A.	No lakes would be stocked.

TABLE 14: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless
Lake Treatments to Manage the Fishery				
Mechanical methods (using gill and fyke nets/electrofishing/ trapping, exclusion of habitat)	No mechanical methods are used to remove fish.	8 lakes	10 lakes	11 lakes
Chemical methods (using chemicals that kill fish)	No chemical methods are used to remove fish.	19 lakes	25 lakes	25 lakes
Natural methods (discontinue stocking)	No natural methods are used to remove fish.	12 lakes	21 lakes	26 lakes
Monitoring Program				
	Trail Blazers and Hi-Lakers perform periodic surveys. From 1968 to 2001, 133 anglers filed 90 reports for 31 lakes. Reports yield estimates of fish abundance, growth, and species composition, as well as angler effort, success, and usage. Continue monitoring macroinvertebrates and expand to include stocked lakes. WDFW would continue to collect data from Trail Blazers and Hi-Lakers. Continue monitoring visitor use. Data related to fishing would be useful in determining adaptive management, especially fish stocking.	Same as alternative A, with additional monitoring of • species assemblages in lakes with fish • visitor use relating to fishing • species assemblages and collecting of physical data needed before treating lakes for fish removal • recovery of species assemblages after treating lakes for fish removal	Same as alternative B.	Same as alternative B.

TABLE 14: ALTERNATIVES ELEMENTS SUMMARY (CONTINUED)

Elements	Alternative A (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless
Mitigation				
	No mitigation occurs under alternative A.	Nonreproducing fish would be stocked to prevent establishment of reproducing, self-sustaining populations of fish. Reproduction would be limited by inducing genetic sterility or selecting hatchery strains that cannot reproduce due to spawning habitat limitations and/or timing of spawning limitations (e.g., Mount Whitney rainbow trout). For lakes with no spawning habitat, fish native to the surrounding watershed (e.g., Ross Lake rainbow trout in the Skagit River basin) would be stocked. Over the long term, the WDFW would also work toward creating hybrid, sterile hatchery strains to further minimize the risks of in-lake reproduction and downstream dispersal and hybridization with native fish. Where applicable, stocking would be rotated to allow resting periods so native species could recover. Stocking methods could be limited to horse or backpack to limit impacts on other park visitors. Protocols for fish removal would be strictly enforced to avoid impacts on other species and on worker and visitor safety (see appendix I).	Same as alternative B.	Fish removal protocols would be strictly enforced to avoid impacts on other species and on worker and visitor safety (see appendix I).
Cost of Implementation				
	Approximately $270,000 over the next 15 years.	Approximately $2.14 million over the next 15 years.	Approximately $2.84 million over the next 15 years.	Approximately $3 million over the next 15 years.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Aquatic Organisms				
	Aquatic organisms (including plankton, macroinvertebrates, and amphibians) would continue to experience long-term negligible to minor adverse impacts from fish predation and competition in lakes stocked with low densities of nonreproducing fish. In lakes with high densities of reproducing fish, certain plankton and macroinvertebrates would continue to experience long-term moderate to major adverse impacts from intensive predation and competition. Long-term minor to moderate adverse impacts on amphibians would continue in lakes with reproducing populations of fish, limited refugia, relatively high nutrient (for example, high total Kjeldahl nitrogen) availability, and limited lake connectivity to other water bodies with suitable amphibian habitat. Long-term moderate to major adverse impacts from hybridization between native and nonnative fish would continue to persist. Short- and long-term adverse cumulative impacts on aquatic organisms would vary widely depending upon trends in aquatic ecosystem stressors such as air pollution, development in surrounding watersheds, and climate change. Overall, the cumulative impacts associated with other actions in the area, added to the impacts predicted under alternative A, would result in short- and long-term minor to	Impacts on aquatic organisms in lakes stocked with low densities of nonreproducing fish would be the same as alternative A, except these impacts would decline further in the future as stocking is curtailed or eliminated in lakes based upon adaptive management decisions pertaining to stocking. Removal of reproducing populations of fish from select lakes would eventually result in long-term beneficial effects on aquatic organisms in those lakes; however, removal of reproducing fish populations would take many years. Until fish are removed, minor to major impacts on aquatic organisms would persist as described in alternative A. Mechanical methods of fish removal (netting, trapping, spawning habitat exclusion) would have short-term negligible to minor adverse impacts on aquatic organisms. Chemical methods of fish removal (application of the piscicide antimycin) would have short-term negligible to moderate adverse impacts on certain aquatic organisms. Compared to alternative A, the risk of hybridization would decline over the long term as reproducing populations of fish are removed, and fewer nonnative fish dispersed downstream from lakes. The risk of hybridization, however, would not be entirely eliminated primarily because reproducing populations of nonnative fish are now present in many	Impacts on aquatic organisms would be similar to alternative B except impacts would only occur in national recreation area lakes that would continue to be stocked with low densities of nonreproducing fish. Removal of reproducing populations of fish from lakes in the national park portion of the North Cascades Complex would have the same effects on aquatic organisms as under alternative B. Impacts of mechanical and chemical methods of fish removal would be the same as under alternative B. Impacts on native fish from hybridization between native and nonnative fish would be the same as under alternative B. Compared to alternative A, there would be a long-term beneficial cumulative impact on populations of native aquatic organisms because a minimum of 51 lakes (all lakes in the national park unit and select national recreation area lakes) would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would be similar to alternative B. Impairment of aquatic organisms across the study area would not occur under alternative C.	Compared to alternative A, long-term beneficial impacts would occur to aquatic organisms as lakes are returned to a fishless condition. Once stocked fish were gone, native aquatic communities would eventually revert to predisturbance (that is, prestocking) conditions, and this would result in long-term beneficial impacts on native aquatic organisms. Removal of reproducing populations of fish from all study area lakes in the North Cascades Complex would have the same effects on aquatic organisms as under alternative B. Impacts of mechanical and chemical methods of fish removal would be the same as under alternative B. Impacts on native fish from hybridization between native and nonnative fish would be the same as under alternative B. Compared to alternative A, there would be a long-term beneficial cumulative impact on populations of native aquatic organisms because all study area lakes in the North Cascades Complex would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would be similar to alternative B. Impairment of aquatic organisms across the study area would not occur under alternative D.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Aquatic Organisms (continued)				
	potentially major adverse impacts on plankton, macroinvertebrates, and amphibians, and/or certain species of native fish in individual lakes in the study area but with overall minor to moderate adverse impacts for the region. Impairment of aquatic organisms across the study area would not occur under alternative A.	drainages throughout the North Cascades Complex. Impacts over the long term would be minor to moderate and adverse. Compared to alternative A, there would be a long-term beneficial cumulative impact on native aquatic organisms because a minimum of 20 lakes would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would be similar to alternative A. Impairment of aquatic organisms across the study area would not occur under alternative B.		
Wildlife				
	The historic and current stocking of fish created suitable conditions for piscivorous wildlife, such as fish-eating ducks, while potentially restricting populations of other species, such as amphibians, that are prey for several wildlife species. Impacts from activities associated with periodic fixed-wing aircraft stocking (noise disturbance) and backpack stocking (human presence and habitat trampling) under alternative A would be short term, negligible to minor, and adverse on wildlife at or near the lakes. Animals that roost or dwell further away from lakes, such an ungulates, bats, rodents, and many forest-dwelling birds, would incur short-term, negligible, adverse impacts or no impacts from stocking activities.	Removal of fish would result in the loss of a food source for fish-eating species, requiring them to disperse to other areas in search of resources; because of this, piscivorous wildlife would incur long-term negligible to minor adverse impacts when lakes are returned to fishless conditions. Impacts from stocking activities would be similar to alternative B, except the number of lakes stocked would decrease under alternative B. Mechanical and chemical treatment methods used to remove fish under alternative B would result in short-term negligible to minor adverse impacts on wildlife, with short-term disturbance to birds and mammals that inhabit the lake and shoreline from the noise of human	Impacts on fish-eating species from removal of fish would be similar to alternative B. Impacts from stocking activities would be similar to alternative B, except the number of lakes stocked would substantially decrease under alternative C. Impacts from mechanical and chemical treatment methods would be the same as alternative B. Cumulative impacts would be similar to alternative A. Impairment of wildlife species across the study area would not occur under alternative C.	Alternative D would have long-term, minor to moderate adverse impacts on fish-eating wildlife in lakes that would become fishless. Removal of fish would result in the loss of habitat for fish-eating species, requiring them to relocate to other areas (potentially outside the North Cascades Complex) in search of resources, which would result in local population decreases for those species, returning the area to pre-stocked conditions. Under alternative D, stocking activities would be eliminated, a benefit to wildlife that would be disturbed by the noise and human disturbance associated with stocking activities.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Wildlife (continued)				
	None of the 91 lakes are currently treated for fish removal under alternative A; therefore, wildlife in or near the lakes would not incur impacts from lake treatments. The impacts associated with other projects and fishery management actions in the area plus impacts from potential airborne pollution, added to the impacts predicted under alternative A, would result in long-term minor adverse cumulative impacts on wildlife populations and communities in the region. Impairment of wildlife species across the study area would not occur under alternative A.	presence and helicopters used to transport equipment for mechanical treatment. Cumulative impacts would be similar to alternative A. Impairment of wildlife species across the study area would not occur under alternative B.		Impacts of treatment methods would be the same as alternative B. Cumulative impacts would be the same as under alternative A. Impairment of wildlife species across the study area would not occur under alternative D.
Special Status Wildlife Species				
	Based on available information, fixed-wing aircraft noise and human disturbance associated with periodic fish-stocking activities under alternative A would have a range of short-term negligible to minor effects on special status wildlife species. Fish removal does not occur under alternative A, so there would be no impacts on special status wildlife species from lake treatments to remove fish.	Fish-stocking activities under alternative B would have a range of short-term negligible to minor effects on some special status wildlife species but would be reduced from the effects that would occur under alternative A. The use of the chemical, antimycin, to remove fish is not known to have adverse impacts on amphibians. There would be long-term beneficial effects on some aquatic species because most high-density reproducing populations of fish would be replaced with low-density nonreproducing stocked fish.	Fish-stocking activities under alternative C would have a range of short-term negligible to minor effects on some special status wildlife species but would be reduced from the effects that would occur under alternatives A and B. Short-term impacts related to lake treatments to remove fish would be minor, mostly due to noise from helicopters transporting lake treatment equipment and human disturbance during treatment activities. Impacts from the use of antimycin to remove fish would be the same as under alternative B.	All fish stocking would be discontinued under alternative D. Short-term impacts related to lake treatments to remove fish would be minor, mostly due to noise from helicopters transporting lake treatment equipment and human disturbance during treatment activities. Impacts from the use of antimycin to remove fish would be the same as under alternative B.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Special Status Wildlife Species (continued)				
	Based on the available information, alternative A would have ***no adverse effects on federally listed species*** from fish stocking. Regarding ***federally listed species:*** **21 species may be affected but are not likely to be adversely affected** (American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, marbled murrelet, Northern goshawk, Northern spotted owl, Pacific fisher, Yuma myotis, long-eared bat, bald eagle, harlequin duck, little willow flycatcher, olive-sided flycatcher, Cascades frog, Columbia spotted frog, northern red-legged frog, bull trout, Chinook salmon, Coho salmon). **2 species would incur no effect** (tailed frog and Western toad). **1 species may be affected and is likely to be adversely affected** (westslope cutthroat trout)—effects would be limited to one drainage downstream from McAlester Lake as a result of documented hybridization and colonization. Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts (solely from noise related to stocking activities), and the common loon would incur short-term negligible adverse impacts. Continuation of stocking would provide beneficial effects by	Based on the available information, alternative B would have ***no adverse effects on federally listed species*** from fish stocking or lake treatments to remove fish. Regarding ***federally listed species:*** **23 species may be affected, but are not likely to be adversely affected:** Same as A, with the addition of the Western toad, and western cutthroat trout. **1 species would incur no effect** (tailed frog). Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts from noise related to stocking and lake treatment activities, and the common loon would incur long-term minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake. Cumulative impacts would be the same as under alternative A. Impairment of special status wildlife species across the study area would not occur under alternative B.	Based on the available information, alternative C would have ***no adverse effects on federally listed species*** from fish stocking or lake treatments to remove fish. Regarding ***federally listed species:*** **23 species may be affected, but are not likely to be adversely affected:** Same as alternative B. **1 species would incur no effect** (tailed frog). Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts from noise related to stocking and lake treatment activities, and the common loon would incur long-term minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake. Cumulative impacts would be the same as under alternative A. Impairment of special status wildlife species across the study area would not occur under alternative C.	Based on the available information, alternative D would have ***no adverse effects on federally listed species*** from lake treatments to remove fish. Regarding ***federally listed species:*** **22 species may be affected, but are not likely to be adversely affected** (American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, little willow flycatcher, marbled murrelet, Northern goshawk, Northern spotted owl, olive-sided flycatcher, Pacific fisher, Yuma myotis, long-eared bat, bald eagle, harlequin duck, Cascades frog, Columbia spotted frog, northern red-legged frog, Western toad, bull trout, Chinook salmon, Coho salmon, and westslope cutthroat trout). **2 species would incur no effect** (Cascades frog and tailed frog). Regarding ***state-listed species that are not federally listed***, 6 species would incur negligible to minor adverse impacts from noise related to fish removal activities, and the common loon would incur minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake. Cumulative impacts would be the same as under alternative A. Impairment of special status wildlife species across the study area would not occur under alternative D.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Special Status Wildlife Species (continued)				
	supporting an adequate food base for nesting loons near Hozomeen Lake and other stocked lakes. Cumulative impacts on each special status species from projects or actions occurring throughout the region would be adverse; however, alternative A would contribute only a small increment to overall cumulative impacts. Impairment of special status wildlife species across the study area would not occur under alternative A.			
Special Status Plant Species				
	Fish-stocking activities at lakes with shoreline meadow or shrub vegetation would have short-term negligible to minor adverse impacts on any special status plants in the shoreline areas of lakes in cross-country zones or near camps with low visitor use. Stocking activities at lakes in zones or near camps with medium to high visitation would result in short-term negligible to major adverse impacts on any special status plants. No lakes are treated for fish removal under alternative A. Trampling by stock (horses, mules, llamas) and visitors (anglers and other visitors) would likely result in minor to moderate cumulative impacts at some lakes and moderate to major at others, depending on the intensity of use and location of sensitive plants.	Fewer lakes would be stocked under alternative B. Trampling during stocking activities may result in negligible to minor adverse impacts at lakes in cross-country zones or near camps that have low visitor use and negligible to moderate adverse impacts on any special status plants that may be present in the shoreline of lakes that are in zones or near camps that receive medium to high use. There would long-term beneficial effects on special status plant species at lakes where stocking would not occur. Select lakes would be treated for fish removal under alternative B. Trampling during mechanical and chemical lake treatment activities may result in short-term negligible to minor adverse impacts on any special status plants that may be present in the shoreline of lakes that are in cross-country zones or near camps	Impacts from stocking activities would be similar to alternative B, except that with considerably fewer lakes stocked, impacts would be reduced to negligible to minor and adverse over the long term. Impacts from mechanical and chemical lake treatment activities to remove fish would be similar to alternative B, although a higher number of lakes would be treated for fish removal under alternative C than under alternative B. Cumulative impacts would be similar to alternative B, except as fish stocking is eliminated in the park, impacts would be reduced to negligible over the long term. Impairment of special status plant species across the study area would not occur under alternative C.	Fish stocking would not occur under alternative D, which would result in long-term beneficial effects on special status plant species. Mechanical and chemical lake treatment activities to remove fish would result in impacts similar to alternative B. Cumulative impacts would be the same as under alternative C. Impairment of special status plant species across the study area would not occur under alternative D.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Special Status Plant Species (continued)				
	Impairment of special status plant species across the study area would not occur under alternative A.	that receive medium to high visitor use, and negligible to minor adverse impacts at lakes in zones or near camps that have low visitor use. Cumulative impacts would be similar to alternative A but would be reduced as fish are removed from lakes. Impairment of special status plant species across the study area would not occur under alternative B.		
Vegetation				
	Fifty-nine of the 62 lakes in the study area where fishing would continue have meadow and/or shrub vegetation. Of these, about 75% have low to medium visitation, and vegetation would experience only negligible impacts. The remaining 25% that have high visitation would continue to experience long-term minor to moderate adverse impacts from trampling. Forest shoreline vegetation would generally not be affected more than a negligible or minor level from visitor use, including angling. Cumulative impacts would be negligible to moderate and adverse over the long term. Impairment of vegetation across the study area would not occur under alternative A.	Twenty-nine of the 35 lakes in the study area where fishing would continue have meadow vegetation that is sensitive to trampling. Eleven of the 29 lakes are within cross-country zones or near camps that would continue to experience low visitor use, with resulting negligible to minor adverse impacts. Eighteen of the 29 lakes are within cross-country zones or near camps that would continue to experience medium to high visitor use, and vegetation would experience negligible to moderate impacts. In addition to the 29 lakes that are currently fishless in alternative A, alternative B would return 20 lakes to a fishless condition with possible negligible to moderate benefits to shoreline meadow vegetation over time. Temporary negligible to moderate adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatments would occur, and continued fishing as a means of natural removal would have	Alternative C would provide substantial long-term benefits to meadow and sensitive forest vegetation from the return of 51 additional lakes to fishless conditions compared to alternative A. The majority of these lakes have meadow vegetation, and 29 of the 51 lakes are located in cross-country zones or near camps that receive a medium to high level of use. To the extent this use is attributable to fishing and fishing-related stock use, benefits to vegetation would occur at these lakes. Of the 9 lakes where fishing would continue, 6 are in cross-country zones or near camps that experience light use now, which would most likely continue to have negligible adverse impacts on vegetation. Three lakes are in cross-country zones or near camps that would continue to experience medium or high use, with resulting negligible to moderate adverse impacts on meadow vegetation. One lake may continue to experience minor or even moderate impacts on	Under alternative D, 62 additional lakes would be returned to fishless conditions compared to alternative A. Vegetation at these lakes would experience overall beneficial impacts. The degree of benefit would range from negligible to moderate and would depend on the level of visitor use, access, sensitivity of the vegetation, and other factors. The majority of these lakes have meadow vegetation. If high visitor use, stock use, and trail use are related to fishing, a decline in fishing opportunity would offer substantial benefits to this more sensitive vegetative community. Temporary negligible or minor adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatment would occur, and continued fishing as a means of natural removal would have short-term negligible to moderate adverse impacts. Adverse cumulative impacts would be negligible to moderate and long term.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Vegetation (continued)				
		short-term negligible to moderate adverse impacts. Adverse cumulative impacts would be negligible to moderate and long term. Impairment of vegetation across the study area would not occur under alternative B.	shoreline forest vegetation. Temporary negligible or minor adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatment would occur, and continued fishing as a means of natural removal would have short-term negligible to moderate adverse impacts. Adverse cumulative impacts would be negligible to moderate and long term. Impairment of vegetation across the study area would not occur under alternative C.	Impairment of vegetation across the study area would not occur under alternative D.
Cultural Resources				
	Alternative A would not change the number of lakes for fishing or the number of anglers using them over the long term. Potential adverse impacts of unknown intensity on archeological resources would be mitigated to negligible to minor. Mitigation would also help keep impacts on historic structures from exceeding minor levels. Potential impacts on cultural landscapes would be mitigated to no greater than minor. No impacts on ethnographic resources are anticipated. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources. Adverse cumulative impacts would range from negligible to minor over the long term.	Possible impacts on archeological resources that would result from preparation of mechanical fish removal equipment and helicopter use (and associated landing pads adjacent to lakes) to transport the equipment would be mitigated to negligible to minor through survey and monitoring prior to use. Possible adverse impacts on historic structures are of unknown magnitude but would not likely exceed negligible to minor. Potential impacts on identified cultural landscapes would be mitigated to no greater than minor. The temporary water-quality degradation from chemicals used to remove fish would potentially result in adverse impacts of unknown intensity on ethnographic resources used by Native Americans for traditional purposes. Such impacts would be	The impact of reduced sport-fishing opportunities would result in negligible impacts on archeological resources in general, with beneficial effects as a result of the return of one lake identified as sensitive to a fishless state. Adverse impacts on historic structures are likely to be negligible; the elimination of fishing at one particularly sensitive lake would result in a benefit to historic structures. Cultural landscapes in the study area may incur no greater than minor adverse impacts; in one case, a benefit to the resources would be realized. Impacts on ethnographic resources would likely be mitigated to negligible. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources.	Under alternative D, the long-term effects of elimination of fishing at all of the mountain lakes in the study area would result in reduced human fishing activity, a benefit to archeological resources in the North Cascades Complex. More specifically, those lake and trail areas identified as sensitive regarding cultural resources would incur benefits by way of reduced risk of disturbance. Adverse impacts on cultural landscapes would likely be negligible; minor benefits may be realized at one designated cultural landscape where fishing would be eliminated. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Cultural Resources (continued)				
	Impairment of cultural resources across the study area would not occur under alternative A.	mitigated to negligible through an agreement with the NPS, affected Tribes, and the State Historic Preservation Office regarding the timing of management activities and locations of specific areas that should be avoided. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources. Adverse cumulative impacts would range from negligible to minor over the long term. Impairment of cultural resources across the study area would not occur under alternative B.	There would be beneficial cumulative impacts for cultural resources from reduced human activity at a number of mountain lakes. Impairment of cultural resources across the study area would not occur under alternative C.	Cumulative impacts would be beneficial. Impairment of cultural resources across the study area would not occur under alternative D.
Visitor Use and Experience				
Recreational Use	Impacts on non-anglers under alternative A would primarily be related to noise and disruption from fixed-wing aircraft stocking activities. Such adverse impacts would be negligible and temporary but would continue over the long term as stocking activities continue. Anglers would experience long-term beneficial impacts because they would continue to enjoy fishing activities unchanged from the past. Cumulative impacts would result from the partial loss of the Stehekin Valley Road due to flooding that occurred in the fall of 2003. The fate of the road is currently uncertain. If the road is not repaired, then access to backcountry portions of the Stehekin	Adverse impacts on non-anglers under alternative B would primarily be related to lake treatment methods. These impacts would be negligible to minor adverse over the long term. Removal of fish from some lakes would reduce visitor use and have some long-term beneficial impacts on non-anglers seeking greater solitude in the backcountry. Impacts on most anglers overall would be minor to moderate, adverse, and long term from management actions under alternative B compared to alternative A. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere.	Same as alternative B. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere.	Same as alternative B. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere. Overall, cumulative impacts would be moderate, adverse, and long term. The cumulative impact of reduced access in the Stehekin Valley due to flood damage would be minor adverse or beneficial to backcountry users.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Visitor Use and Experience (continued)				
Recreational Use (continued)	Valley may be more difficult, and this would reduce the amount of backcountry visitation. Some visitors might enjoy the increased solitude and wilderness setting, while others might lament the reduced access to backcountry areas in the Stehekin Valley, including fishable lakes. Therefore, adverse cumulative impacts on visitor use would be minor to moderate over the long term.	Cumulative impacts related to angler displacement to overused areas outside the North Cascades Complex would overall be minor to moderate, adverse, and long term. The cumulative impact of reduced access in the Stehekin Valley due to flood damage would be minor adverse or beneficial to backcountry users.		
Social Values	Continuation of existing management actions under alternative A would have a beneficial effect on the social values of anglers and angler groups because stocking and sport fishing would not change. Impacts on social values of conservationists and conservation groups would be long term, moderate to major, and adverse. Continuation of management actions as described in alternative A would not alter angler use; therefore, cumulative impacts on social values of anglers would be long term and beneficial. Continuation of management actions as described in alternative A would have a moderate to major adverse cumulative impact on conservationists and conservation groups.	Alternative B would have a minor adverse impact on the social values of anglers and angler groups over the long term because some level of stocking and sport fishing would continue over the long term. Impacts on social values of conservationists and conservation groups would be beneficial for some who would support the new management framework but moderate to major adverse and long term for those who oppose any stocking of lakes over the long term. Alternative B would have a moderate to major adverse cumulative impact on conservationists and conservation groups, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts on anglers and angling groups would be moderate to major, adverse, and long term, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts related to flood damage to upper Stehekin Valley Road would be minor to moderate, adverse, and long term.	Alternative C would have a moderate to major adverse impact on the social values of anglers and angler groups over the long term because sport fishing would eventually be eliminated in the national park, and many anglers and angler groups believe that fishing in the park is a unique opportunity that cannot be duplicated elsewhere. Impacts on social values of conservationists and conservation groups would be the same as under alternative B. Cumulative impacts would be the same as under alternative B.	Alternative D would have a moderate to major adverse impact on the social values of anglers and angler groups over the long term, especially for those who use and value the park for this experience. Anglers may choose to pursue sport fishing outside the North Cascades Complex. Overall, impacts on social values of conservationists and conservation groups would be beneficial. Cumulative impacts would be the same as under alternative B.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Visitor Use and Experience (continued)				
Wilderness Values	Backpack stocking would have a short- and long-term negligible direct impact on visitor solitude. Given the brief and infrequent nature of fixed-wing aircraft stocking, there would be a short- and long-term minor adverse impact on opportunities for solitude. Sport-fishing opportunities would remain at current levels. This would result in long-term negligible impacts on opportunities for solitude for those areas that receive relatively little use, and would result in long-term minor adverse impacts on opportunities for solitude for those areas that receive high use. Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be long-term minor to moderate and adverse. Those with an anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience negligible long-term impacts under alternative A. Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience major, long-term adverse impacts by the continued fishery management practices under alternative A. Impacts on wilderness users who are unaware that fish are present in the lakes would be negligible over the long term. Cumulative impacts on fishing opportunities in mountain lakes from	Backpack and fixed-wing aircraft stocking would result in impacts similar to alternative A, except fewer lakes would be stocked. Fishery management actions would reduce sport-fishing opportunities compared to alternative A. This would result in a long-term minor beneficial impact on opportunities for solitude in some areas. However, some lakes in certain high-use areas would remain fishable, resulting in minor adverse impacts on opportunities for solitude over the long term. The impacts on solitude from fish removal activities would be minor to moderate and adverse over the long term. Anglers who choose to fish elsewhere due to the reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience long-term major adverse impacts. Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be minor to moderate adverse over the long term. Those with anthropocentric perspective would experience negligible long-term impacts under alternative B. Those with an anthropocentric perspective may view the application of a science-based adaptive management plan as a negligible impact, and some may view this as beneficial. Those with strong biocentric views of wilderness would experience long-term major	Backpack and fixed-wing aircraft stocking would result in impacts similar to alternative A, except to a lesser degree because fewer lakes would be stocked, and these lake would only be in the national recreation areas. Fishery management actions would reduce sport-fishing opportunities compared to alternatives A and B. Sport-fishing opportunities would be eliminated in national park lakes but would continue to exist in select national recreation area lakes. This would result in a long-term moderate beneficial impact on opportunities for solitude in some areas. However, some lakes in certain high-use areas would remain fishable, resulting in long-term minor adverse impacts on opportunities for solitude. Impacts on solitude from fish removal activities would be long term minor to moderate and adverse. Anglers who choose to fish elsewhere due to the reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience major adverse long-term impacts. Impacts on visitor opportunities for primitive recreation in high-use areas over the summer would be long term minor to moderate and adverse. Those with an anthropocentric perspective would experience long-term moderate adverse impacts under alternative C due to the loss of	Sport-fishing opportunities would be vastly reduced compared to alternative A because all stocking in the North Cascades Complex would cease, and fish would be removed from all lakes, where feasible. This would result in long-term moderate to major beneficial impacts on opportunities for solitude in areas where fishing opportunities are eliminated. However, fishing opportunities would continue to exist in the nine deep lakes where complete fish removal may not be feasible, resulting in long-term minor adverse impacts on opportunities for solitude. Impacts on solitude from fish removal activities would be minor to moderate and adverse over the long term. Anglers who choose to fish elsewhere due to reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience long-term major adverse impacts. The cessation of anglers using wilderness would result in long-term beneficial impacts on other visitors. Those with an anthropocentric perspective would experience long-term major adverse impacts. Those with an anthropocentric perspective may view the application of a science-based adaptive management plan to remove fish as a negligible impact, and some would view this as beneficial.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Visitor Use and Experience (continued)				
Wilderness Values (continued)	reduced access would likely be negligible over the short and long terms. There would be a long-term major adverse cumulative impact on those who believe that continued stocking and continued presence of reproducing fish populations under alternative A would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and enjoyment of wilderness should continue.	adverse impacts from fishery management actions under alternative B. Some with biocentric perspectives would view the application of a science-based adaptive management plan as beneficial over the long term. Impacts on wilderness users who are not aware that fish are present in the lakes would be negligible over the long term. Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms. There would be a long-term major adverse cumulative impact on those who believe that the continued stocking (as proposed under alternative B) in wilderness and continued presence of reproducing populations of fish would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles in wilderness areas, cumulative impacts would be long term beneficial or adverse. Fishery management actions, including fish removal, would have a minor adverse cumulative impact on solitude over the long term.	fishable lakes in the national park; however, fishing opportunities would still remain in wilderness areas in select national recreation area lakes. Those with an anthropocentric perspective may view the application of a science-based adaptive management plan as a negligible impact, and some may view this as beneficial over the long term. Those with strong biocentric views of wilderness would experience long-term major adverse impacts from the fishery management actions under alternative C. Some with biocentric perspectives may view the application of a science-based adaptive management plan as beneficial over the long term. Impacts to wilderness users who are not aware that fish are present in the lakes would be negligible over the long term. Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms. There would be a long-term major adverse cumulative impact on those who believe that the stocking proposed under alternative C and continued presence of reproducing populations of fish would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and	Those with strong biocentric views of wilderness would experience major long-term beneficial impacts because all fish would be removed (where feasible) under alternative D. Some with a biocentric perspective may view the application of a science-based adaptive management plan as beneficial over the long term. Impacts to those wilderness users who would not be aware that nonnative fish have been removed from the lakes would be negligible over the long term. Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms. There would be major long-term beneficial cumulative impacts on those who believe that continued stocking in wilderness and continued presence of reproducing populations of fish would compromise natural processes. There would be long-term major adverse cumulative impacts on anglers who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles to remove fish from wilderness areas, cumulative impacts either would be beneficial or adverse over the long term. Fishery management actions, including fish removal, would have minor adverse cumulative impacts on solitude over the long term. Due to the cessation of

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Visitor Use and Experience (continued)				
Wilderness Values (continued)			enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles in wilderness areas, cumulative impacts either would be beneficial or adverse over the long term. Fishery management actions, including fish removal, would have a long-term minor adverse cumulative impact on solitude. Due to the cessation of stocking in national park lakes, long-term moderate beneficial cumulative impacts on wilderness values would be expected.	stocking, moderate to major beneficial cumulative impacts on wilderness values would be expected over the long term. The displacement of anglers to other wilderness areas would result in negligible adverse cumulative impacts, even if all anglers decided to fish elsewhere.
Human Health				
	Alternative A would have negligible impacts on human health over the long term from the consumption of stocked fish that may have been exposed to persistent organic pollutants and methyl-mercury, and no adverse impacts on human health from any lake treatment chemicals since none would be used. Cumulative impacts on human health would be negligible adverse over the long term.	Impacts from stocking decisions and consumption of stocked fish would be the same as alternative A. Proposed chemical treatments that would be used to remove fish from 19 lakes would have long-term negligible adverse impacts on human health. Cumulative impacts on human health would be negligible to minor adverse over the long term.	Impacts from stocking decisions and consumption of stocked fish would be the same as alternative A. Impacts from the proposed chemical treatment of 25 lakes would be the same as alternative B. Cumulative impacts on human health would be the same as alternative B.	Impacts from consumption of fish from previously stocked lakes would be the same as alternative A. Impacts from the proposed chemical treatment of 25 lakes would be the same as alternative B. Cumulative impacts on human health would be the same as alternative B.

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Socioeconomic Resources				
	Alternative A would have long-term negligible impacts on the local and regional economies. Estimated revenues from mountain lake angling account for roughly $1 out of every $100,000 spent in the three-county region. The effects of continuation of the current fishery management program on some local businesses in the Stehekin area would be beneficial since some patrons may also engage in sport fishing in the mountain lakes located in Lake Chelan National Recreation Area. Expenditures associated with sport fishing in the mountain lakes in the North Cascades Complex would continue to have long term negligible cumulative impacts on the local and regional economies.	Similar to alternative A but with potential long-term major adverse impacts on a limited number of businesses in Stehekin due to reduced fishing opportunities in mountain lakes. Cumulative impacts would be similar to alternative A.	Similar to alternative B, except that anglers who no longer would have fishing opportunities in high mountain lakes in the national park may choose to fish in the national recreation areas. This would have a beneficial long-term impact on local businesses in Stehekin. However, if the number of anglers choosing to fish in the mountain lakes in the recreation areas substantially decrease, there would be a long-term major adverse impact on some businesses in Stehekin. Cumulative impacts on the local and regional economies overall would be long term and negligible, while some businesses in Stehekin may experience long-term major adverse impacts because other visitor uses are not expected to increase substantially. There would be beneficial economic impacts on Stehekin area businesses if anglers chose to fish in the Lake Chelan National Recreation Area because fishing in the mountain lakes outside of the national recreation areas would be eliminated.	Overall, the local and regional economies would experience long-term negligible to minor adverse impacts from the elimination of sport fishing in the mountain lakes in the study area. Compared to alternative A, some Stehekin businesses would experience long-term major adverse impacts under alternative D if their primary source of income is from anglers who fish in the study area lakes. Overall, cumulative impacts would be long term, negligible, and adverse.
Management and Operations				
	Alternative A would have a negligible to minor adverse impact on management and operations over the long term. Total implementation costs would be $270,000 over a 15-year period and would primarily be borne by the WDFW. Average annual costs would be approximately $18,000 per year.	Alternative B would have moderate adverse impacts on management and operations over the long term, assuming all sources of funding remain fairly constant. Total implementation costs would be approximately $2.14 million over the next 15 years. Average annual costs for implementation are projected at	Alternative C would have similar moderate adverse impacts on management and operations as alternative B over the long term. Total implementation costs would be approximately $2.84 million over the next 15 years. Average annual costs would be similar to alternative B, but	Alternative D would have moderate adverse impacts on management and operations over the long term, assuming all funding sources remain fairly constant. Total cost of implementing alternative D would be approximately $3 million over the next 15 years. Average annual costs

TABLE 15: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topics	Alternative A (No Action) Existing Framework of 91 Lakes	Alternative B Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)	Alternative C Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Management and Operations (continued)				
	Cumulative impacts would be negligible to minor and adverse over the long term.	approximately $112,100 for the first three years. As experience is gained conducting lake treatment and management, the number of lakes treated increases, raising costs to nearly $150,000 per year. Future stocking would be funded and implemented by the WDFW. However, should a long-term increase in NPS base funding for fishery management become available, implementing alternative B would have negligible to minor adverse impacts over the long term. Other sources of funding would be sought to reduce impacts on the park's operating budget. Cumulative adverse impacts on operations could arise from the need to respond to future unanticipated events such as flooding, wildfire, or other events. However, the magnitude of adverse impacts may range from negligible to major depending on the severity of individual future events, which could reduce the amount of potential funding available to implement the fishery management plan or cause the NPS to shift priorities to respond to more pressing needs.	the additional lakes targeted for fish removal would increase the total cost. Future stocking would be funded and implemented by WDFW. Similar to alternative B, if a long-term increase in NPS base funding becomes available, adverse impacts would become minor. Other sources of funding would be sought to reduce impacts on the park's operating budget. Cumulative impacts would be the same as alternative B.	for fish removal would be similar to alternative C. Although there are no average annual costs associated with fish stocking, the additional costs of protection required to prevent unsanctioned stocking of lakes would increase total implementation costs. Other sources of funding would be sought to reduce impacts on the park's operating budget. Cumulative impacts would be the same as alternative B.

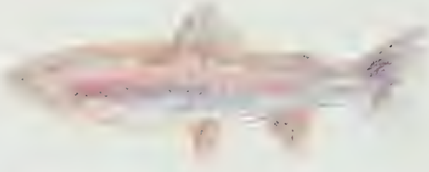
TABLE 16: ANALYSES OF HOW ALTERNATIVES MEET OBJECTIVES

Objectives	Alternative A: (No Action) Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish (Preferred Alternative)	Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 National Recreation Area Lakes May Have Fish)	Alternative D: 91 Lakes Would Be Fishless (Environmentally Preferred Alternative)
Obtain support from interested parties and groups to implement a new management plan for mountain lakes in the North Cascades Complex should the governing agencies decide a new plan is needed.	Meets objective to some degree. Some groups/parties would support a new management framework, but others may not depending on their individual views on protection of North Cascades Complex resources and values and availability of angling opportunities.	Meets objective to some degree. Some groups/parties would support a new management framework, but others may not depending on their individual views on protection of North Cascades Complex resources and values and availability of angling opportunities.	Meets objective to some degree. Some groups/ parties would support a new management framework, but others may not depending on their individual views on protection of North Cascades Complex resources and values and availability of angling opportunities.	Meets objective to some degree. Some groups/ parties would support a new management framework, but others may not depending on their individual views on protection of North Cascades Complex resources and values and availability of angling opportunities.
Advance the protection and rehabilitation of native biological integrity by maintaining native species abundance, viability, and sustainability.	Does not fully meet objective. Reproducing populations of fish would continue to exist in naturally fishless lakes, adaptive management practices would not be fully implemented, and stocking would continue to impact native biota.	Fully meets objective. Adaptive management strategies would remove populations of reproducing fish that are adversely impacting native biota in the park and recreation areas.	Fully meets objective. Adaptive management strategies would remove populations of reproducing fish that are adversely impacting native biota in the park. Adaptive management would be applied in the recreation areas to remove reproducing populations of fish and restocking lakes, as appropriate, with nonreproducing fish or fish native to the watersheds.	Fully meets objective. All lakes would be returned to their naturally fishless condition in the park and recreation areas, thereby maintaining native species abundance, viability, and sustainability throughout the mountain lakes.
Provide a spectrum of recreational opportunities, including sport fishing, while minimizing impacts on the biological integrity of natural mountain lakes.	Meets objective to some degree. A spectrum of recreational opportunities would continue, including sport fishing; however, the impacts of the current program would continue to adversely affect native biota and biological integrity of natural mountain lakes.	Meets objective to a large degree. Application of adaptive management strategies would remove reproducing fish that harm native biota, while restocking lakes with low densities of nonreproducing fish or fish native to the watersheds. Some lakes in both the park and recreation areas would remain available for angling while minimizing the impacts of stocking through adaptive management practices over the long term. Some illegal stocking in lakes returned to a fishless condition may occur.	Meets objective to some degree. Mountain lakes in the park would be returned to their naturally fishless condition over time. Some illegal stocking of fish in park lakes may occur. Lakes in the recreation areas would be treated to remove populations of reproducing fish, and some would be restocked to allow for angling opportunities.	Does not fully meet objective. All mountain lakes in the park and recreation areas would be treated to return lakes to their naturally fishless condition. Angling opportunities would be available in some lakes in that the period for restoration may span 20-30 years. Fishing in the reservoirs and streams would still be available. Some illegal stocking of fish in lakes may occur.

TABLE 16: ANALYSES OF HOW ALTERNATIVES MEET (CONTINUED)

Objectives	Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish)	Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes in the National Park and National Recreation Areas May Have Fish)	Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes in the National Recreation Areas May Have Fish)	Alternative D: 91 Lakes Would be Fishless
Apply science and research in decision-making at multiple spatial scales that include landscape, watershed, lake cluster, and individual lakes.	Does not fully meet objective. While the current program does apply available science and good practices to some degree, it does not systematically apply adaptive management at a landscape, watershed, lake cluster, or individual lake scale.	Meets objective to a large degree. Adaptive management strategies would be applied with evolving science and knowledge as lakes are returned to their naturally fishless conditions. Lakes would be treated using mechanical, chemical, or natural methods to remove reproducing populations of fish while minimizing impacts on native biota. Lakes identified for restocking would be monitored and prescriptions adjusted depending upon how well native biota respond to treatment and stocking over the long term.	Meets objective to a large degree. Similar to alternative B, adaptive management strategies would be applied throughout the lakes; however, only those lakes in the recreation areas would be identified for restocking. Lakes would be treated by mechanical, chemical, or natural methods to remove reproducing populations of fish while minimizing impacts on native biota. Lakes in the recreation areas identified for restocking would be monitored and prescriptions adjusted depending upon how well native biota respond to treatment and stocking over the long term.	Meets objective to a large degree. Adaptive management strategies would be applied as fish are removed from all naturally fishless lakes throughout the park and recreation areas. Lakes would be treated by mechanical, chemical, or natural methods to remove reproducing populations of fish while minimizing impacts on native biota.
Provide to the public and interested parties full and open access to available information.	Does not meet objective. While information is available, it is not systematically and consistently provided to the public and interested parties.	Fully meets objective. As adaptive management strategies are applied and knowledge gained, outcomes would be made available to the public through various media. If monitoring revealed that a change in strategies would be necessary, the public and interested parties would be notified, and additional opportunity for public input would be provided.	Fully meets objective. As adaptive management strategies are applied and knowledge gained, outcomes would be made available to the public through various media. If monitoring revealed that a change in strategies would be necessary, the public and interested parties would be notified, and additional opportunity for public input would be provided.	Fully meets objective. As adaptive management strategies are applied and knowledge gained, outcomes would be made available to the public through various media. If monitoring revealed that a change in strategies would be necessary, the public and interested parties would be notified, and additional opportunity for public input would be provided.

Canada
Mt. Baker Wilderness
Mt. Shuksan
North C
Nationa
(north
Baker Lake
Skagit River
Marblemount
Sauk River
Suiattle River
Darrington
Boulder River Wilderness
0
5
10
20



Affected Environment

Welcome

You are now in the "Affected Environment" chapter. Here are the topics you can read about.

North C
Nationa
(north

INTRODUCTION 147

AQUATIC ORGANISMS 157

WILDLIFE 179

SPECIAL STATUS SPECIES 183

VEGETATION 196

CULTURAL RESOURCES 201

VISITOR USE AND EXPERIENCE 204

HUMAN HEALTH 219

SOCIOECONOMIC RESOURCES 221

NORTH CASCADES COMPLEX MANAGEMENT AND OPERATIONS 229

INTRODUCTION

THIS "AFFECTED ENVIRONMENT" chapter describes the resources of the North Cascades National Park Service Complex (also referred to in the document as the "North Cascades Complex") that could be affected as a result of implementation of any of the proposed fishery management alternatives. The resource descriptions provided in this chapter serve as the baseline from which to compare the potential effects of the management actions considered in this *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS). The resource topics presented in this chapter, and the organization of the topics, correspond to the resource impact discussions contained in the "Environmental Consequences" chapter that follows this chapter.

GENERAL PROJECT SETTING

GEOGRAPHIC SETTING

The National Park Service (NPS) administers three units that make up the North Cascades Complex. Those three units are North Cascades National Park (505,000 acres), Ross Lake National Recreation Area (117,000 acres), and Lake Chelan National Recreation Area (62,000 acres). The North Cascades Complex is located in the northernmost portion of the Cascade Mountain Range in northwestern Washington State (refer to "Figure 1: Vicinity Map" in the "Purpose of and Need for Action" chapter). The North Cascades Complex is surrounded by approximately 6 million acres of National Forest System lands, including the Mount Baker-Snoqualmie National Forest to the south and the Okanogan National Forest to the east.

North Cascades National Park is divided into two administrative units: the North Unit and the South Unit. These two units are split geographically by Ross Lake National Recreation Area, which contains three reservoirs (Ross, Diablo, and Gorge lakes) created by the dams of the Skagit River Hydroelectric Project. The lakes provide a variety of recreational opportunities such as boating, sport fishing, tours of the hydroelectric facilities, and short hiking trails. The Skagit River Hydroelectric Project includes two small "company" towns: Newhalem and Diablo. It also includes a very large infrastructure of dams, penstocks, power houses, and associated maintenance facilities. In partnership with NPS and the North Cascades Institute, Seattle City Light is constructing an Environmental Learning Center on the shores of Diablo Lake.

Ross Lake has two developed areas that provide recreational opportunities for park visitors: Ross Lake Resort and Hozomeen. Located in the shadow of Ross

Dam, Ross Lake Resort is a small assemblage of floating cottages operated by a private concessioner. Hozomeen is a semiprimitive visitor-use area situated in Ross Lake National Recreation Area on the United States-Canadian border. Visitor amenities at Hozomeen include several campgrounds, a boat launch, several docks, and a trail leading to Hozomeen Lake and points beyond. The Silver-Skagit Road, which originates near Hope, British Columbia, is the only road access to Hozomeen. Visitors can also access Hozomeen by boat but only when Ross Lake Reservoir is at or near full pool. Predominant visitor use is camping, boating, and sport fishing. Many visitors to Hozomeen are Canadian citizens. Approximately 8,200 people visited Hozomeen in 2002.

The last major developed area in Ross Lake National Recreation Area is the highway corridor along State Route 20, commonly referred to as the "North Cascades Highway," which provides the only road access across the North Cascades Complex. State Route 20 is closed in winter because of heavy snowfall and avalanche dangers. There are a variety of trailheads and rest stops along the highway that provide viewpoints and access to the remote interior portions of the North Cascades Complex. In 1992 the average vehicle use along State Route 20 through Ross Lake National Recreation Area was approximately 1,300 vehicles per day (WDOT 2002).

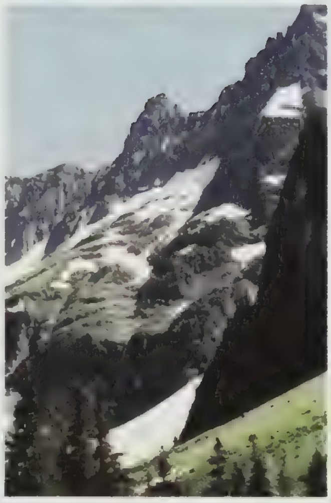
The community of Stehekin is the only development in Lake Chelan National Recreation Area. Situated at the head of Lake Chelan, Stehekin is a settlement of year-round and summer homes and recreation-oriented businesses. There is no road access to Stehekin. The only access is by trail, ferry, boat, or small airplane. The Stehekin Valley Road, a 21 mile dead-end road, leads north from Stehekin into the interior portions of the North Cascades Complex.

The North Cascades Complex has approximately 386 miles of maintained trails, including a portion of the Pacific Crest Trail that runs from southern California to the Canadian border. There is also a network of climbing routes and way-trails throughout the North Cascades Complex that lead to various mountaineering, sport fishing, and other backcountry destinations. The NPS does not formally maintain these trails.

WILDERNESS

Approximately 634,600 acres, or 93%, of the North Cascades Complex are designated and managed as wilderness (NPS 1989) under the provisions of the *Wilderness Act of 1964*. Roughly 1.6 million acres of National Forest System lands that surround the North Cascades Complex are also designated as wilderness. To the east are the Pasayten Wilderness (529,477 acres) and Lake Chelan-Sawtooth Wilderness (151,435 acres); to the south is the Glacier Peak Wilderness (570,573 acres); and to the west are the Mount Baker Wilderness (117,528 acres) and Noisy-Diobsud Wilderness (14,133 acres).

The border between the United States and Canada forms the northern boundary of North Cascades National Park and Ross Lake National Recreation Area. Just over the border into Canada are E.C. Manning Provincial Park, Skagit Valley Provincial Park, Chilliwack Lake Provincial Park, and various forest lands administered by the province of British Columbia. Though not designated as "wilderness," these Canadian protected areas are, for the most part, extremely rugged, wild, and remote, and they further complement the wilderness buffer that largely surrounds the North Cascades Complex. It is particularly important to note that these Canadian areas provide habitat corridors and source populations of medium- and large-sized mammals of conservation significance, such as grizzly bears and wolves.



The North Cascades Complex contains some of the most rugged and remote wilderness in the contiguous United States.

Because the North Cascades Complex is almost 93% wilderness, the majority of lands in the national park and two national recreation areas have not been developed. In accordance with the *General Management Plan* (NPS 1988b) for the North Cascades Complex, these areas are managed as "natural zones" to ensure that natural resources and processes remain largely unaltered by human activity. All of the natural lakes in the North Cascades Complex fall under the "natural zone" category for management purposes.

Research Natural Areas, which are special subzones of natural zones, were given that designation by the NPS because of their unique natural features with essentially no past human influence. There are five Research Natural Areas in the North Cascades Complex. Two of these, Silver Lake Research Natural Area (1,627 acres) and Pyramid Lake Research Natural Area (164 acres), are centered around mountain lakes. Silver Lake was last stocked in 1961, and surveys performed in 1980 showed no fish remained in the lake. Pyramid Lake was last stocked in 1968, and surveys performed as recently as 1999 indicated no fish remained in the lake. Although both lakes were stocked in the past, current management of Research Natural Areas involves strict protection of their scientific values.

GEOLOGIC OVERVIEW

This section provides an overview of the geology of the North Cascades Complex to demonstrate the inextricable link between hydrology and geology. The geology of the North Cascades Complex has a profound influence on various hydrologic processes such as rainfall, runoff, and the physical structure of lakes and streams and their associated water quality.

Geologists have divided the region into three main geologic domains. From west to east, these domains include the Western domain, the Metamorphic domain, and the Methow domain.

The Western domain consists mostly of sedimentary and volcanic rocks of marine origin. Notable peaks in this domain include Mount Baker and Mount Shuksan.

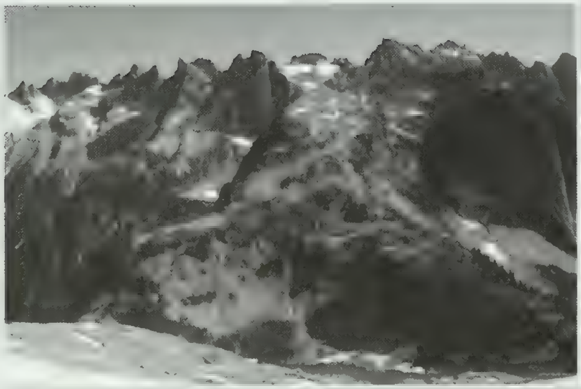
The Metamorphic domain is composed of metamorphosed crystalline rocks, such as the steep vertical layers of granite that were formed under intense heat and pressure deep within the earth. Often referred to as the "crystalline core," this domain is most visibly expressed in the rugged, remote peaks of the Picket Range.

Metamorphism: In geological terms, the changes in the composition and texture of rocks caused by heat, pressure, moisture, and other factors.

Tectonic: The study of the movement and deformation of the earth's crust.

East of the Cascade Crest lies the Methow domain, composed of unmetamorphosed sedimentary rocks of marine and volcanic origin. This domain is separated from the Metamorphic domain by the Ross Lake fault. Each of the three geologic domains consists of many tectonic terrains, or relatively homogenous sections (in other words, the same character or composition throughout) of the earth's crust that have formed according to the geologic principles of plate tectonics. The many different tectonic terrains create an exceedingly complex mountain mosaic of many different types of rock (Tabor and Haugerud 1999).

The Metamorphic domain consists of two major mountain divides: the Skagit Crest and the Pacific Crest. These two divides have a profound influence on the climate and hydrology of the North Cascades Complex. The Picket Range and Eldorado Range form the boundary of the Skagit Crest. The Pacific Crest Trail roughly forms the boundary of the Pacific Crest, which lies further east. These two mountain divides give rise to three hydrologic zones: the first is west of the Skagit Crest; the second is the Central basin, which is also referred to as the Ross Lake basin; and the third lies east of the Cascade Crest. Moving from west to east along these hydrologic zones, precipitation and runoff decline substantially due to the rain shadow effect produced by the high peaks of the Skagit Crest. The Cascade Crest creates a climatic barrier between the west-side maritime climate and the east-side semiarid continental climate. This climatic barrier is useful for distinguishing between "west-side" and "east-side" lakes, though this classification is slightly complicated by the rain shadow effect produced in the lee of the Picket Range in the area around Ross Lake. Based on records from nearby weather stations, the average annual precipitation is about 100 inches on the west side and 60 inches on the east side.



The Picket Range (shown above), along with the Eldorado Range, form the boundary of the Skagit Crest.

HYDROLOGY OF THE NORTH CASCADES COMPLEX

The creeks and rivers of the North Cascades Complex drain into three regional watersheds: the Skagit River watershed, the Fraser River watershed (via the Chilliwack River), and the Columbia River watershed (via the Stehekin River). The Skagit River is the largest watershed in the Puget Sound area. Major tributaries that enter the Skagit, or that drain significant parts of the North Cascades Complex, include Little Beaver, Lightning, Big Beaver, Devils, Ruby, and Thunder creeks and the Cascade River. The Stehekin River drains into Lake Chelan and eventually into the Columbia River. The Chilliwack River originates in the northwest corner of the North Cascades Complex and drains northward into the Fraser River. "Map 1" is located in the envelope that accompanied this document and shows the creeks, rivers, lakes, and reservoirs described in this chapter.

Ross Lake National Recreation Area contains three reservoirs along the Skagit River: Ross Lake (11,680 acres), Diablo Lake (910 acres), and Gorge Lake (210 acres). These three reservoirs make up the Skagit River Hydroelectric

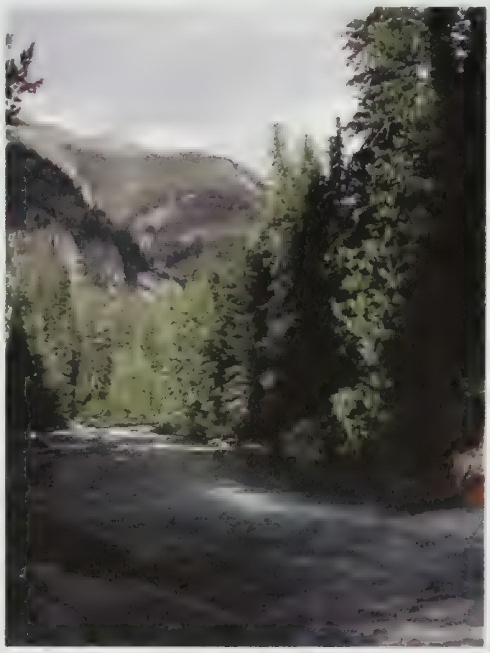
Project, owned and managed by Seattle City Light. Although these reservoirs were considered in the impact analysis portion (the "Environmental Consequences" chapter) of this plan/EIS, they are beyond the scope of this document because they are manmade reservoirs and not naturally formed mountain lakes.

Geologists believe that the Skagit River once flowed northward into the Fraser River drainage. At the end of the last ice age (about 13,000 years ago), huge amounts of glacial meltwater were blocked by the Cordilleran ice sheet, and this blockage caused the Skagit River to reverse course and carve out the Skagit River gorge between Newhalem and Diablo. This phenomenon, called drainage reversal, was widespread in the North Cascades Range (Tabor and Haugerud 1999). As a result of drainage reversal, the Skagit River watershed can be broken down into upper and lower reaches. The Upper Skagit watershed extends well into Canada and includes the upper sections of the Skagit River, Ross Lake, and various other smaller creeks including Big Beaver, Little Beaver, Lightning, and Thunder. The Lower Skagit River watershed begins in the Skagit River gorge between the towns of Diablo and Newhalem. Major tributaries to the Lower Skagit watershed in the North Cascades Complex include the Cascade River and the upper reaches of Baker River, upstream of Baker Lake.

Glaciers play a significant role in the hydrology of many of the streams and lakes in the North Cascades Complex.

On the east side of the Cascade Crest is the Stehekin River drainage. Most of the Stehekin River watershed is in the North Cascades Complex and the Glacier Peak Wilderness. Major tributaries along its course include five creeks: Bridge, Company, Agnes, Rainbow, and Boulder. Near the southern end of Lake Chelan National Recreation Area, the Stehekin River joins the deep blue-green waters of Lake Chelan.

Lake Chelan, perhaps one of the most remarkable examples of glacial erosion in the North Cascades Complex, is a natural lake 50 miles long (4 miles of which are in the Lake Chelan National Recreation Area) and 1,500 feet deep—one of the deepest lakes in North America. A dam constructed in 1927 added 21 feet to the level of Lake Chelan, giving it a full-pool surface elevation of approximately 1,010 feet above mean sea level (the 1982 to 1990 mean). The lake levels fluctuate on an annual basis, with an average drawdown of 18 feet by late winter / early spring to accommodate snowmelt for hydropower generation. Full pool is usually restored by early July.



The Stehekin River originates as snow and glacial meltwater near Cascade Pass.

The glaciers provide extremely cold water, help maintain summer base flows in the dry summer season following spring snowmelt, and contribute high loads of suspended sediment and various nutrients to lakes and rivers. The North Cascades Complex has approximately 330 glaciers. The minimum elevations of glaciers (glacier threshold) rise from west to east across the North Cascades Range due to lower snow accumulations and higher summer temperatures on the eastern slope of the range. Along the Pacific Crest portion of the North Cascades Complex, most glaciers are located south of Cascade Pass. North of Cascade Pass, most of the glaciers are found along the crest of the Skagit Range (also referred to as the Eldorado and Picket ranges). Throughout the North Cascades Complex, glaciers are located primarily on cooler north- and east-facing slopes.

Glacier monitoring data indicate that the glaciers are melting rapidly. Since the end of the Little Ice Age in the late 1800s, glaciers have retreated throughout the North Cascades Complex, and it is likely that over 100 glaciers have disappeared from the North Cascades Complex since the late 19th century. Continuing shrinkage and disappearance of glaciers in the North Cascades Complex mean that its hydrology, aquatic ecosystems, and vegetation are changing as well. One result of glacial melting is that new lakes are being formed, and existing cirque lakes are expanding as their parent glaciers melt. Silver Lake is an excellent example of such a lake. From 1901 to 1906, Canadian geologist Reginald Daly mapped the glacier on Mt. Spickard (then Glacier Peak) as entirely covering the lake basin. Today, the glacier has retreated significantly and exposed an indigo-colored lake (Silver Lake) over 1 mile long (Beckey 1995) and more than 500 feet deep.

The lakes in the North Cascades Complex can be classified according to the geologic processes, particularly the glacial processes, that formed them. This method of classification is commonly referred to as lake morphometry (Wetzel 2001).

Aside from glacial runoff, flooding plays an important role in the hydrology of the North Cascades Complex, and floods can happen at any time of year, but are more common under certain conditions. Summer floods usually occur during thunderstorms and associated periods of intense rainfall. These floods usually affect areas that are less than 10 square miles in size. Spring floods occur in May or June during peak snowmelt. The magnitude of these floods varies depending on the depth of winter snowpack and spring weather (precipitation, freezing level, and temperature). The most extreme flood events usually occur in winter during heavy rain events associated with unusually warm temperatures (high freezing level) and a pre-existing heavy snowpack.

OVERVIEW OF MOUNTAIN LAKES

The North Cascades Complex has 561 permanent natural water bodies that include lakes, tarns (small mountain lakes formed by glaciers), and ponds. There are an unknown number of seasonal ponds that flood following snow melt but eventually dry up over the course of the summer. Approximately 245 of the permanent water bodies are considered mountain lakes because of their larger size and depth. Also, lakes and ponds are usually distinguished according to whether or not sunlight can reach the bottom (Wetzel 2001). For the purpose of this plan/EIS, each of the 91 water bodies with a history of fish stocking is considered a lake. Silver and Pyramid lakes also have a stocking history (they are currently fishless) but are not part of this plan/EIS because they are in one of the Research Natural Areas described earlier in this chapter.

The mountain lakes with a history of fish stocking are dotted throughout the major watersheds in the North Cascades Complex and occur at elevations ranging from about 1,350 feet above mean sea level at Thunder Lake to 6,795 feet above mean sea level at Stiletto Lake (see table 17). The mountain lakes occur in four broad vegetation zones: lowland forest, montane (high) forests, subalpine parkland, and alpine. Lakes are found in all four zones on both sides of the Cascade Crest and range in size from less than 1 acre to

TABLE 17: RANGE OF PHYSICAL ATTRIBUTES FOR MOUNTAIN LAKES WITH A HISTORY OF FISH STOCKING

	Size (acres)	Depth (feet)	Elevation (feet above mean sea level)
Mean	16	55.2	4,981
Median	5.4	25.9	5,140
Maximum	162 (Silver Lake*)	522 (Silver Lake)	6,795 (Stiletto Lake)
Minimum	0.2 (Panther Potholes, upper)	9 (Panther Potholes, upper)	1,350 (Thunder Lake)

Note:

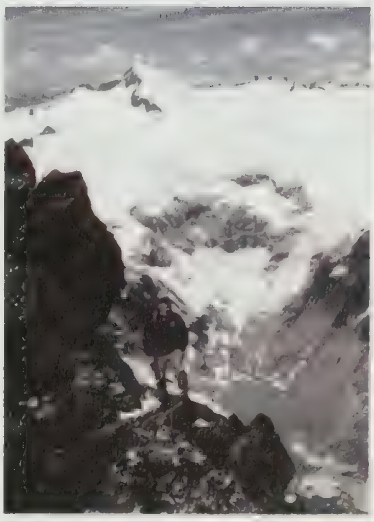
* Silver Lake has a history of fish stocking but is now fishless. It is in a Research Natural Area and not included in this plan/EIS.

approximately 162 acres (Silver Lake). Many of the lakes in the park (64%) are less than 10 acres. There are only 9 lakes greater than 50 acres and only 3 lakes greater than 100 acres. This skewed distribution follows a similar pattern with respect to lake depth: there are only 12 lakes greater than 100 feet and only 4 lakes greater than 200 feet deep. Silver Lake is the largest (162 acres) deepest (522 feet), and nearly highest (6,700 feet above, mean sea level) lake of the mountain lakes. The attributes of the 91 lakes analyzed in this plan/EIS are presented in appendix E.

Silver Lake is classified as a cirque lake.

The mountain lakes in the North Cascades Complex are characterized by eight classes: cirque, trough, ice scour, moraine, bench, fault, slump, and kettle.

- Cirque lakes exist at the head of U-shaped glaciated (or formerly glaciated) valleys (Silver Lake is a cirque lake and, excluding Lake Chelan, the deepest in the North Cascades Complex).
- Trough lakes were formed in glacially scoured U-shaped valleys. They tend to be long, narrow, and wedge-shaped, with the deepest spots in the lakes near their outlets.
- Ice-scour lakes occur in irregular depressions and are often found on ridgetops. These lakes generally tend to be shallow.
- Moraine lakes formed behind terminal or lateral moraines that were deposited by receding glaciers.
- Bench lakes are literally found on topographic benches (relatively flat areas).
- Fault lakes were formed by bedrock dams created by differential displacement of bedrock along tectonic faults.
- Slump lakes occur in the depression left by the rotational “slip” of deep-seated soil.
- Kettle lakes were formed by depressions or “kettles” left after a glacier retreated.



Skymo Lake is classified as a moraine lake.

The lakes of the North Cascades Complex occupy a wide range of elevations, geologic terrains, and vegetation types. There are a variety of lake attributes, with large differences in shape, surface area, temperature, and depth. No two lakes are alike; each lake is a unique result of the physical, chemical, and biological processes that shaped the surrounding lake basin and the lake itself. These processes continue to unfold as glaciers melt and new lakes are born and as older lakes slowly accumulate sediment, organic matter, and woody debris. One way to measure these dynamic processes is by analyzing the water quality of the lakes.

MOUNTAIN LAKES WATER QUALITY

The term "water quality" is used to describe the physical, chemical, and biological condition of water as influenced by natural processes and human activities. There are many ways to characterize and quantify water quality, and selection of appropriate methods often depends on the intended use of the water or the water body (Novotny and Olem 1994). For lakes in the North Cascades Complex, the "intended use" of water is for maintenance of ecological functions and processes and preservation of human values such as recreation, aesthetics, and clean water for consumption. These intended uses reflect the need for water and water bodies of the highest and most unimpaired quality.

The common physical and chemical measurements of water quality include temperature, pH, alkalinity, dissolved oxygen, conductivity, and nutrients such as nitrogen and phosphorus that are important for photosynthetic organisms such plants, algae, and phytoplankton (primary producers) and for indirectly sustaining organisms at higher levels in the food chain. Approximately 105 of the lakes in the North Cascades Complex have been surveyed by park biologists and affiliated researchers for one or more parameters of baseline water quality; some lakes have been surveyed repeatedly over many years. The results of those surveys have yielded some broadly descriptive patterns and correlations with physical, chemical, and biological processes that may have important implications for mountain lakes fishery management.

pH is the measure of the acidity or alkalinity of a solution, such as vinegar, or a damp substance, such as soil. The pH of pure water is 7, with lower numbers indicating acidity and higher numbers indicating alkalinity.

Broadly speaking, lakes in the North Cascades Complex are relatively cold, neutral in pH (i.e., neither overly acidic nor alkaline), low in concentration of dissolved solids, and also low in concentration of inorganic nutrients such as phosphorus and nitrogen. Taken together, these parameters indicate that most of the lakes in the North Cascades Complex are oligotrophic or ultra-oligotrophic (Liss et al. 1995). Oligotrophic means the lakes contain relatively little plant life and nutrients but are rich in dissolved oxygen. Under these conditions, the lakes are low in productivity and capacity to sustain aquatic life through primary production (Wetzel 2001). Although lakes can be somewhat uniformly described as oligotrophic, there is a great deal of variation in water quality among the mountain lakes due to a variety of factors including geographic distribution, elevation, aspect, and morphology (shape and structure) of the lake basin.

The biological productivity of lakes in the North Cascades Complex is strongly influenced by lake elevation and basin aspect. These two factors greatly affect the length of time a given lake remains frozen each year. Low-elevation lakes have the longest ice-free periods, and high-elevation alpine lakes have the

shortest ice-free periods. Some high-elevation lakes, particularly lakes with easterly or northerly exposures, may not thaw following a winter with heavy snowfall (NPS, J. Reidel, pers. comm., 2003). Most lakes, however, become ice-free by mid-July and freeze over by late October to early November. Lakes on the west side of the Cascades tend to freeze over about two weeks later than lakes on the east side. The generally short ice-free season in the North Cascades Complex has a great influence on the survival and reproductive potential of both native species and stocked fish.

Water quality parameters (water temperature, pH, alkalinity, conductivity, total Kjeldahl nitrogen (TKN), ammonia nitrogen, and total phosphorus) tend to decline at higher elevations, but nitrogen, in the form of nitrates, increases in concentration at higher elevations. Lakes with a strong glacial influence contain higher levels of phosphorus. Lake depth also appears to have some influence on water quality; for example, concentrations of alkalinity, conductivity, TKN, and total phosphorus appear to be higher in shallow lakes (less than 32 feet deep) than in deeper lakes. Lake-basin geology does not appear to play a major role in segregating most lakes based on water quality (Liss et al. 1995), although the higher pH level of certain lakes (such as Ridley Lake with a pH of 8.3) may be related to the limestone composition of the underlying geologic terrains (for example, Hozomeen terrain).

ORIGIN OF MOUNTAIN BIOTA

All the mountain lakes in the North Cascades Complex were at one time fishless because of topographic barriers, such as cascades, that obstructed fish migration. Though lacking in fish, the lakes were far from barren of aquatic life. When the glaciers receded following the last ice age, a dynamic process of dispersal and colonization occurred, giving rise to a rich array of aquatic organisms that eventually colonized the mountain lakes. This process, which continues today, varied greatly among the different organisms. Most insects flew or were carried by wind to the lakes. Smaller zooplankton may have been carried on up-valley breezes (OSU, G. Larson, pers. comm., 2003). Larger species of crustacean zooplankton and amphipods may have been transported on feathers, in the digestive byproducts of waterfowl, or in fur of semi-aquatic mammals (Daborn 1976; Peck 1975). The amphibians slowly spread over land or followed watercourses. Recent genetic research (Shields and Liss 2003) indicates that long-toed salamanders may have colonized the east and west sides of the North Cascades from two separate glaciers. Over long periods of time, the lakes were colonized by a unique, fishless assemblage of aquatic and semi-aquatic organisms.

Biota: The total complement of all the animals and plants in a given area.

The following sections describe the various organisms (invertebrate and vertebrate) that researchers have found in North Cascades Complex lakes. Because it is believed that fish are not native to mountain lakes prior to their introduction by humans, this section is intended to describe the predisturbance, or historic conditions, of mountain lakes in the North Cascades Complex based on available information and professional judgment. Fish stocking has taken place now for more than a century, and it may not be possible to truly understand the pre-stocking diversity, abundance, and distribution of native species.

The term "biota" refers to the total complement of all the animals and plants in a given area.

AQUATIC ORGANISMS

INTRODUCTION

This section describes four main groups of aquatic organisms that are key components of the lake ecosystems in the North Cascades Complex.

Plankton (free-floating microscopic plants (phytoplankton) and animals (zooplankton)

Macroinvertebrates (larger invertebrate animals like worms and insects)

Amphibians (frogs and salamanders)

Fish

Each of these plays an important role in maintaining desirable conditions in mountain lake ecosystems and in preserving the biological resources of the lakes. A large part of an organism's importance has to do with its role in the lake food web; that is, its "trophic level" or "trophic role." This basically comes down to "who eats whom" and if there is sufficient food to support higher levels of organisms within the lake and sustain the lake's desired ecological condition. Each group of organisms also plays a role in the cycling of nutrients in the lake ecosystem by taking up and/or releasing nitrogen and phosphorus, which are needed for the production of plants that support the overall productivity of the lake. The following "Introduction to Lake Ecology" should help the reader form a basic understanding of these roles and the importance of each group of aquatic organisms.

INTRODUCTION TO LAKE ECOLOGY

How Aquatic Systems Work: Food Chains/Webs and Nutrient Cycling

The relationships between biological communities within a lake ecosystem may be organized conceptually into a food chain or, more realistically, a food web. A food chain is a simple representation of the flow of food energy from one level to another, usually starting with plants that can make food through photosynthesis, and leading up to the "top" consumer. For a mountain lake, a simple food chain might resemble something like this:

Phytoplankton → Zooplankton → Macroinvertebrates → Amphibians → Fish

Each level in the food chain is called a "trophic" level, and the plants that make the food are referred to as primary producers. Organisms further up the chain are called the consumers or predators and are often divided into those that eat plants (herbivores) or those that eat animal tissue or meat (carnivores). Generally, there are a lot more producers and lower-level consumers in a food chain, since they are needed to support larger organisms at the top—the top predators. However, in real life, many species eat a variety of organisms (omnivores) and are not necessarily tied to particular trophic level. Also, consumers often shift levels throughout their life cycle. For example, a larval fish may initially eat fine particulate material and small zooplankton, and it may then switch and graze on larger zooplankton and, ultimately, end up feeding on salamander eggs and larvae when it reaches maturity. Therefore, relationships in a mountain lake are more realistically portrayed as a food web. Figure 8 depicts the simplified food web for a typical mountain lake.

The density of plankton varies depending on the availability of nutrients and stability of the water. A liter of lake water could contain more than 500 million planktonic organisms.

The following is a summary of connections between the organisms depicted in the food web:

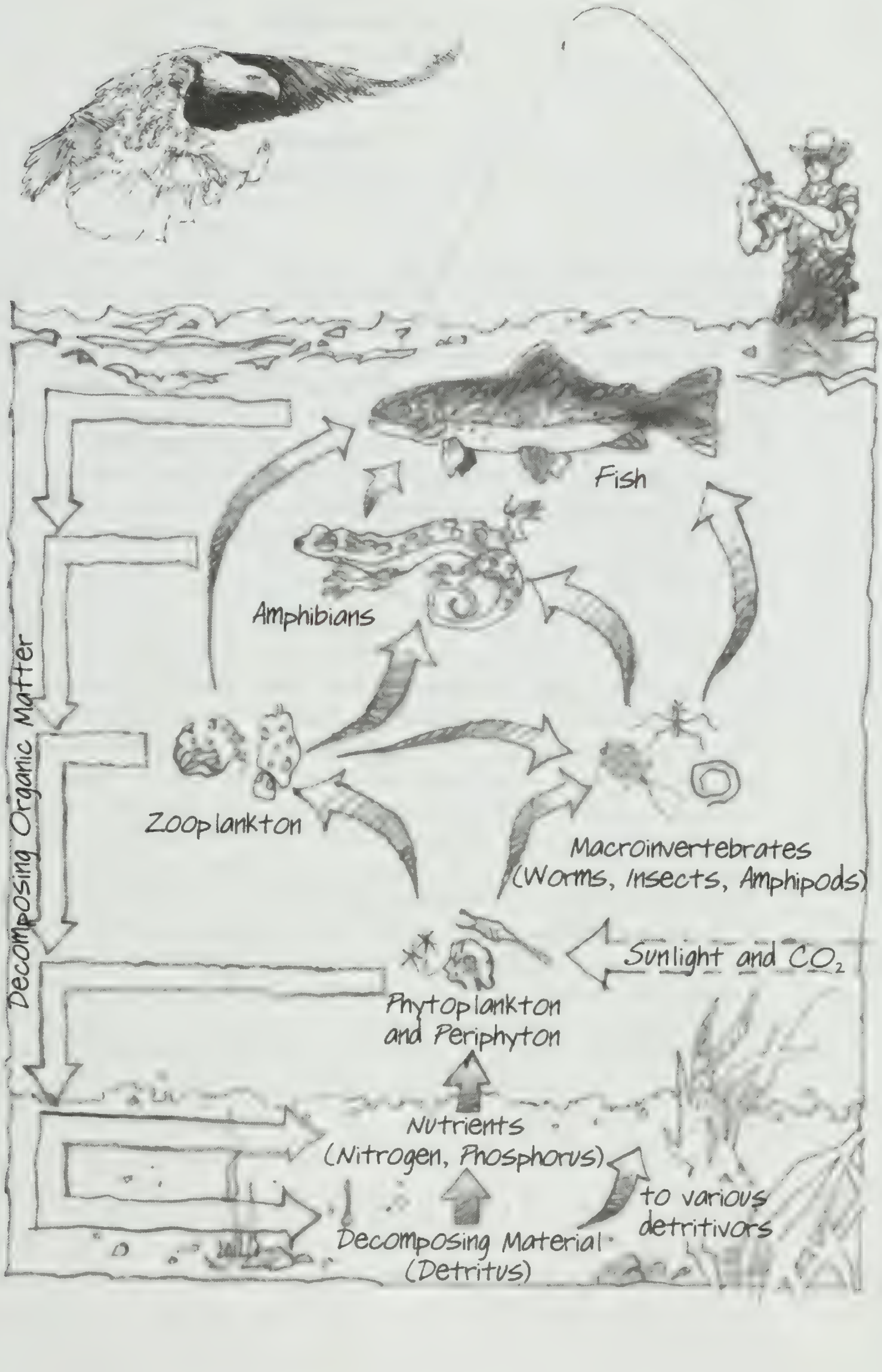
Phytoplankton—these, along with the periphyton (algae attached to rocks or other substrates) are the primary producers in a lake ecosystem and form the base of the food web. These organisms undergo a process called photosynthesis in which they take energy from sunlight and convert nonliving, inorganic material (carbon dioxide, water, and nutrients) into living, organic plant tissue. Oxygen is released as a byproduct of this process. Generally, phytoplankton are not directly affected by fish predation but are indirectly affected by changes in the food web caused by fish introduction.

Zooplankton—these include a wide variety of microscopic animals such as copepods and cladocerans. They are the first consumer level in the food web. Most grazing zooplankton species feed on phytoplankton, but some smaller ones are, in turn, preyed upon by other larger zooplankton species. Zooplankton are directly affected by fish predation and indirectly affected by changes in the food web caused by fish introduction.

Macroinvertebrates—these include organisms such as aquatic insects, snails, amphipods (scuds), and a variety of worms. These organisms primarily eat phytoplankton, periphyton, and zooplankton and may also consume detritus (decaying plants and animals) for food. Macroinvertebrates are directly affected by fish predation and indirectly affected by changes in the food web caused by fish introduction.

Amphibians—these include salamanders and frogs, which consume zooplankton and macroinvertebrates. Much of the consumption depends on the stage of the particular amphibian in its life cycle. For instance, salamander larvae consume mostly zooplankton, while adult salamanders eat larger macroinvertebrate larvae and adult insects and worms. Amphibians are directly affected by fish predation and competition for prey and indirectly affected by changes in trophic interactions and nutrient cycling caused by fish introduction.

FIGURE 8: FOOD WEB FOR A LAKE WITH FISH


Fish
Amphibians
Decomposing Organic Matter
Zooplankton
Macroinvertebrates
(Worms, Insects, Amphipods)
Sunlight and CO_2
Phytoplankton
and Periphyton
Nutrients
(Nitrogen, Phosphorus)
to various
detritivors
Decomposing Material
(Detritus)

Fish—these include many stocked and introduced species. Juvenile fish feed primarily on zooplankton and the smaller macroinvertebrates, while adult fish may eat larger zooplankton, macroinvertebrates, and amphibian larvae. Native fish are directly affected by predation by introduced fish species, competition for habitat and prey, and in some cases, hybridization (interbreeding).

Humans, bears, eagles, and other large predators—although not directly part of the aquatic food web, these are the top predators in the entire lake system of the North Cascades Complex when fish are available.

As shown on figure 8, nutrients are also part of the picture, and they cycle through the system. Nutrients, such as nitrogen and phosphorus, are needed for plant production and the overall productivity of a lake. When organisms die, nutrients contained in the decaying organic matter (called detritus) are released as this material decomposes. Nitrogen, in particular, is also contained in wastes excreted by organisms (fish excrete quite a bit more nitrogen than others, given their size). Just like houseplants, phytoplankton use these nutrients to grow and develop. The more nutrients, the more phytoplankton can grow to support upper trophic levels, and the more productive the lake. On the other hand, an abundance of nutrients in a lake can cause an unusual increase in the amount of phytoplankton that develops.

It is important to discuss and analyze these organisms in this plan/EIS because they serve as vital links that ensure the stability and biological resources of the ecosystem. If a particular species is reduced or eliminated from the food web, other organisms in the system are affected, just like breaking a strand in a web will put new stresses on the remaining strands and change the structural stability of the web. The concern about stocked fish to a naturally fishless lake comes from the potential effects on the trophic relationships and the nutrient balance in the lake (in other words, potential changes in the food web). For example, certain stocked fish may eat a large quantity of zooplankton, which can reduce the amount of food available to other organisms (such as some macroinvertebrates) that depend on zooplankton for their food supply. Also, with fewer zooplankton, certain species of smaller zooplankton or phytoplankton may increase. Fish also add nutrients through their waste elimination, and this could add to the increase in phytoplankton or other producers as more nitrogen is available. All these shifts and changes can cause an imbalance in the normal functioning of the ecosystem, and in some cases, important links in the food chain or sensitive species could actually be eliminated.

HOW ORGANISMS ARE ORGANIZED: ECOSYSTEMS, COMMUNITIES, POPULATIONS, AND METAPOPULATIONS

Another way aquatic organisms are organized is by their relationship with other species and their environment. In this case, we are not talking about trophic levels, but rather the different levels of organisms as defined by their genetic connections and their connections with the other components of their environment. In general, from smaller to larger, there is a "biological spectrum" that can be depicted as

Genes → Cells → Organs → Organisms → Populations → Communities → Ecosystems

In the analysis provided in the "Environmental Consequences" chapter, the focus is mainly on impacts at the population and community levels, which have implications at the ecosystem level. A population (sometimes called "species population") is a collective group of organisms of the same species occupying a particular geographic space. For example, the analysis may discuss a population of long-toed salamanders or a population of certain species of phytoplankton in a lake.

A community is any group of populations living in a certain geographic area or physical habitat. For example, the phytoplankton community consists of all the different species of phytoplankton in a lake. In some cases, the extent of geographic distribution is best described as a cluster of geographically discrete (separate) populations that are connected by infrequent, but critical, interbreeding. This is then referred to as a metapopulation. For example, the geographic extent of a population of aquatic macroinvertebrates with a flying adult phase, such as caddisflies, is generally determined by drainage basin boundaries. Adult caddisflies from one population may frequently disperse to other drainage basins and interbreed with other populations, forming a metapopulation relationship. This is important because metapopulation relationships allow for recolonization of suitable habitats where populations, for some reason, are no longer present.

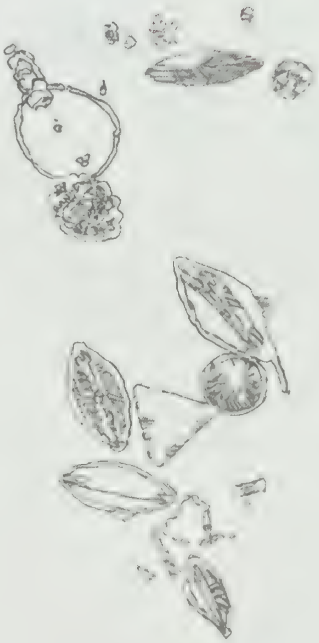
Finally, an ecosystem includes both the living and nonliving components in an area—the organisms and their physical environment, which includes the soil, sediments, air, and water they use and live in.

PLANKTONIC ORGANISMS

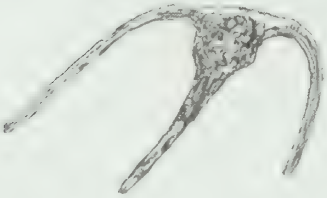
Planktonic or "free-floating" organisms can be found in lakes throughout the North Cascades Complex. These organisms include phytoplankton, which are free-floating microscopic plants, and zooplankton, their animal counterparts.

PHYTOPLANKTON

Phytoplankton are tiny photosynthetic plants that float within the water column. The phytoplankton community in mountain lakes consists of many different types of microscopic and submicroscopic organisms that include diatoms, blue-green algae, green algae, and photosynthetic flagellates (Reid and Wood 1976). Just like other algae or land-based plants, phytoplankton transform sunlight and carbon dioxide into organic tissue through photosynthesis and are, therefore, considered "primary producers." When phytoplankton die (or are consumed), they become organic matter or food that is available for organisms at higher levels in a lake's food web. Because they are the first link in the aquatic food web, phytoplankton are vital components of the lake ecosystems of the North Cascades Complex.



Diatoms are single-celled algae with a cell wall made of silica.



Flagellates, like diatoms, are phytoplankton responsible for producing energy and forming the base of the aquatic food chain.

As discussed previously in the section titled "Mountain Lake Water Quality," the water quality of the lakes is influenced by such factors as lake elevation and temperature, the concentration of dissolved solids, total Kjeldahl nitrogen (TKN), and water temperature increases relative to decreasing lake elevation. The physical and chemical characteristics of lakes tend to change with changes in elevation. Phytoplankton densities and productivity tend to increase with decreasing lake elevation and associated changes in water quality. The lower the elevation and higher the water temperature of a lake, the more likely it is to have higher levels of dissolved solids and TKN, an indicator of the potential for plant growth and lake productivity (Larson et al. 1999b). The density of phytoplankton, which is a large part of the measured productivity of a lake, also increases along this same gradient; that is, it is higher in low-elevation warmer lakes with high levels of dissolved solids and TKN (Larson et al. 1998). The productivity and diversity of phytoplankton also tend to increase with increasing amounts of the nutrient phosphorus in lakes (Larson et al. 1998).

As mentioned previously, phytoplankton are at the base of the aquatic food web of mountain lakes. Top predators in North Cascades Complex lakes, such as salamanders and fish, do not feed on the tiny phytoplankton. It is the zooplankton and other invertebrates that feed on phytoplankton, and they in turn, are consumed by larger animals such as fish and salamanders. Fish stocking, however, can disrupt the natural balance of the density and species of phytoplankton that would usually occur in fishless lakes. Zooplankton that would normally graze on phytoplankton may be consumed by fish, resulting in higher densities of phytoplankton or a particular species of phytoplankton. Fish waste products may increase nutrient levels and cause changes in phytoplankton populations outside the normal range of variability.

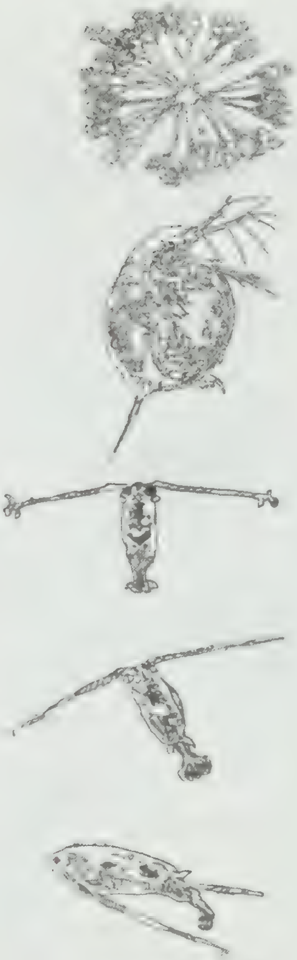
ZOOPLANKTON

Zooplankton are microscopic animals that are free-floating in the water column. They include a wide variety of organisms, including protozoans, rotifers, and crustacean zooplankton. Protozoans are one-celled plankton that include ciliates (those with cilia, or small hair-like projections) and flagellates (those with whip-like projections). Rotifers have retractable crowns of cilia that create currents to draw in food. They are widely distributed in the lakes of the North Cascades Complex and may be the dominant zooplankton under certain conditions. The crustacean zooplankton community includes cladocerans and copepods.

Cladocerans, commonly called "water fleas," are small, generally transparent crustaceans that feed on small organic particles. *Daphnia* are the most commonly known genus of cladoceran. These small herbivorous (plant-eating) zooplankton are often referred to as the "cattle" of lakes and ponds because they graze primarily on phytoplankton. In contrast to the flat disc-like shape of cladocerans, copepods are a type of crustacean zooplankton with a cylindrical and segmented shape. Copepods exhibit a wide variety of feeding preferences, even consuming other zooplanktonic organisms. In the food web of mountain lakes, the larger cladocerans and copepods are a very important component of the food base for larger vertebrate organisms such as larval amphibians and fish (Wetzel 2001; Brönmark and Hansson 1998).

The crustacean zooplankton communities in lakes of the North Cascades Complex are very diverse, and more detail about their ecology can be found in documents that are posted on the website developed for this plan/EIS (http://www.nps.gov/npca/highlakes.htm). This research, which is summarized in the "Purpose of and Need for Action" chapter, indicates that zooplankton are found in all 91 lakes addressed in this document, including the lakes with fish. Five species of diaptomid zooplankton inhabit the lakes in the North Cascades Complex: *Diaptomus kenai, D. articus, D. tyrelli, D. lintoni*, and *D. leptopus*. The most common large diaptomid, *D. kenai*, is able to persist over a wide range of conditions—even conditions that would not be expected to support living organisms (Liss et al. 1998). The densities of zooplankton are not known for all the lakes in the North Cascades Complex, but results from the study of a subset of lakes indicate that the densities of copepods are affected by temperature, nutrient levels, and especially, fish predation. In general, much of the research indicates that high densities of fish, especially reproducing fish that can build up to very high densities and form multiple age classes over time, can cause a substantial decrease in the density of certain large copepods due to predation (Liss et al. 1998). Lower densities of fish, more typical of stocked situations, do not have as great an effect. There is not much difference in abundance of diaptomid copepods between these stocked lakes and fishless lakes (Liss et al. 1998), possibly because the densities are not as high in stocked lakes, and the zooplankton can recover between stockings.

In addition, it was found that copepods are more abundant in deeper lakes with high fish densities than in shallower lakes with high fish densities because it is thought that the zooplankton use the deeper waters to escape predation (Liss et al. 1998). For herbivorous copepods, the nutrient level of a lake is also important. The small herbivorous copepod, *L. tyrelli*, is restricted to shallow lakes (less than 32 feet deep) with relatively high concentrations of TKN and total phosphorus. Also, some smaller herbivorous copepods serve as food for the larger zooplankton, and the smaller copepods may flourish when a lake is stocked and fish eat many of the larger zooplankton (Liss et al. 1998).



Five species of diaptomid zooplankton inhabit the lakes in the North Cascades Complex.

MACROINVERTEBRATES

The term "macroinvertebrate" is often used generically to describe a diverse array of aquatic invertebrate organisms that are large enough to be seen clearly with the naked eye. Many larval and adult macroinvertebrates (such as *Chaoborus*, a phantom midge) in lake ecosystems are also planktonic or free-floating, so the distinction between planktonic organisms and macroinvertebrates in this discussion is useful but somewhat arbitrary.

Research into the ecology and numbers of macroinvertebrates in the lakes of the North Cascades Complex has focused largely on the nearshore macroinvertebrates, primarily because of the logistical limitations of sampling deeper water. Also, predators, such as salamanders and fish, are known to feed selectively on macroinvertebrates in the shallow nearshore areas of lakes.

The recent research into the ecological effects of stocked fish in the lakes of the North Cascades Complex (Liss et al. 1995) found 88 nearshore classifications of

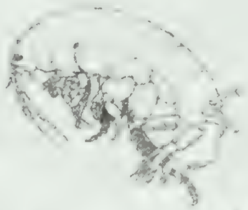
macroinvertebrates, representing 16 distinct taxonomic groups including aquatic insects, gastropods (snails), amphipods (scuds or sandhoppers), nematodes (unsegmented worms), oligochaetes (segmented worms), and turbellaria (flatworms). The presence of nearshore macroinvertebrates in lakes in the North Cascades Complex is associated with habitat and food availability, plus lake water temperature and elevation (Hoffman et al. 1996). In general, higher elevation lakes, which are colder and have less nearshore vegetation and food availability, contain fewer types of macroinvertebrates. Research found that 83% of different taxonomic groups inhabit lower-elevation forest-zone lakes, 61% inhabit subalpine lakes, and only 16% inhabit higher alpine lakes (Hoffman et al. 1996).

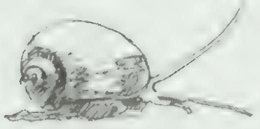
Macroinvertebrates are a very important food source for salamander larvae and fish, the two top vertebrate predators in lakes in the North Cascades Complex (Tyler et al. 1998a; Liss et al. 1995). When lakes with vertebrate predators were compared to lakes without vertebrate predators, statistically significant differences were found in the abundance of three types of aquatic insects: a stonefly (*Taenionema*), a mayfly (*Ameletus*), and a caddisfly (*Desmona mono*). The larval stonefly was far less abundant in lakes with vertebrate predators, though the role of fish predation in reducing its abundance could not be determined. The mayfly was found almost exclusively in lakes without salamanders or fish, but salamander predation, not fish predation, appeared to limit its distribution. Only the caddisfly appeared to be limited by fish predation (Liss et al. 1995).

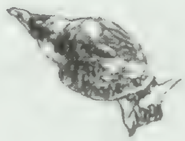
The caddisfly is an herbivore (feeds on plants) and detritivore (feeds on decaying plant or animal material) that is commonly found throughout the western United States, particularly in stream habitats (Merrit and Cummins 1996). In the North Cascades Complex, the caddisfly, *D. mono*, is found in lakes on both sides of the Cascade Crest, but it is more common in subalpine lakes than forested lakes (Liss et al. 1995).

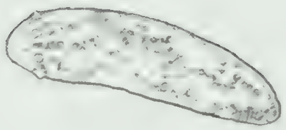
As part of a program for long-term monitoring of aquatic resources in the North Cascades Complex, NPS biologists have been collecting nearshore benthic macroinvertebrates (those that live on lake bottoms) to identify long-term trends in the biological resources of lakes and streams. Benthic macroinvertebrates are especially suited for long-term monitoring of ecosystem health because they are widely distributed, and certain taxa are quite sensitive to pollution and other human-caused stresses. The benthic macroinvertebrate monitoring has detected *D. mono* in over 50 of 88 surveyed lakes in the North Cascades Complex, indicating that the species is a common and widely distributed taxon, primarily in lakes without fish.

Amphipods are laterally compressed crustaceans in the order Amphipoda; they resemble tiny shrimp. More commonly called "scuds" or "sandhoppers," they can be a very important food source for fish in freshwater habitats (Reid and Wood 1976; Brönmark and Hansson 1998). Three kinds of amphipods (*Stygobromus* sp., *Gammarus lacustris*, and *Hyalella azteca*) have been collected in about 10 lakes (including Hozomeen Lake) in the North Cascades Complex.



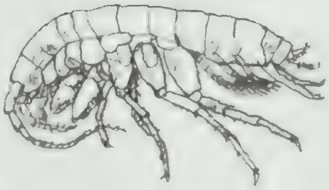






The term "macroinvertebrate" is often used generically to describe a diverse array of aquatic invertebrate organisms that are large enough to be seen clearly with the naked eye.

Recent sampling of benthic macroinvertebrates in fishless lakes led to the discovery of an unusual genus of blind amphipod not previously found in the Pacific Northwest. The blind amphipod, belonging to the genus *Stygobromus*, was collected from two relatively shallow lakes: Redoubt Lake (maximum depth—46 feet) and Upper East Lake (maximum depth—unknown). Redoubt Lake was last stocked with fish in 1967 but has since become fishless. This finding was an interesting new record for the western United States since the only other known taxon in the genus *Stygobromus* was collected from very deep water in Lake Tahoe, California. According to the taxonomist who identified the amphipod, it is unusual that a blind amphipod would be found in such shallow water (ODU, J. Holsinger, pers. comm., 2001).



The "blind amphipod" was found in water samples taken from Redoubt Lake and Upper East Lake.

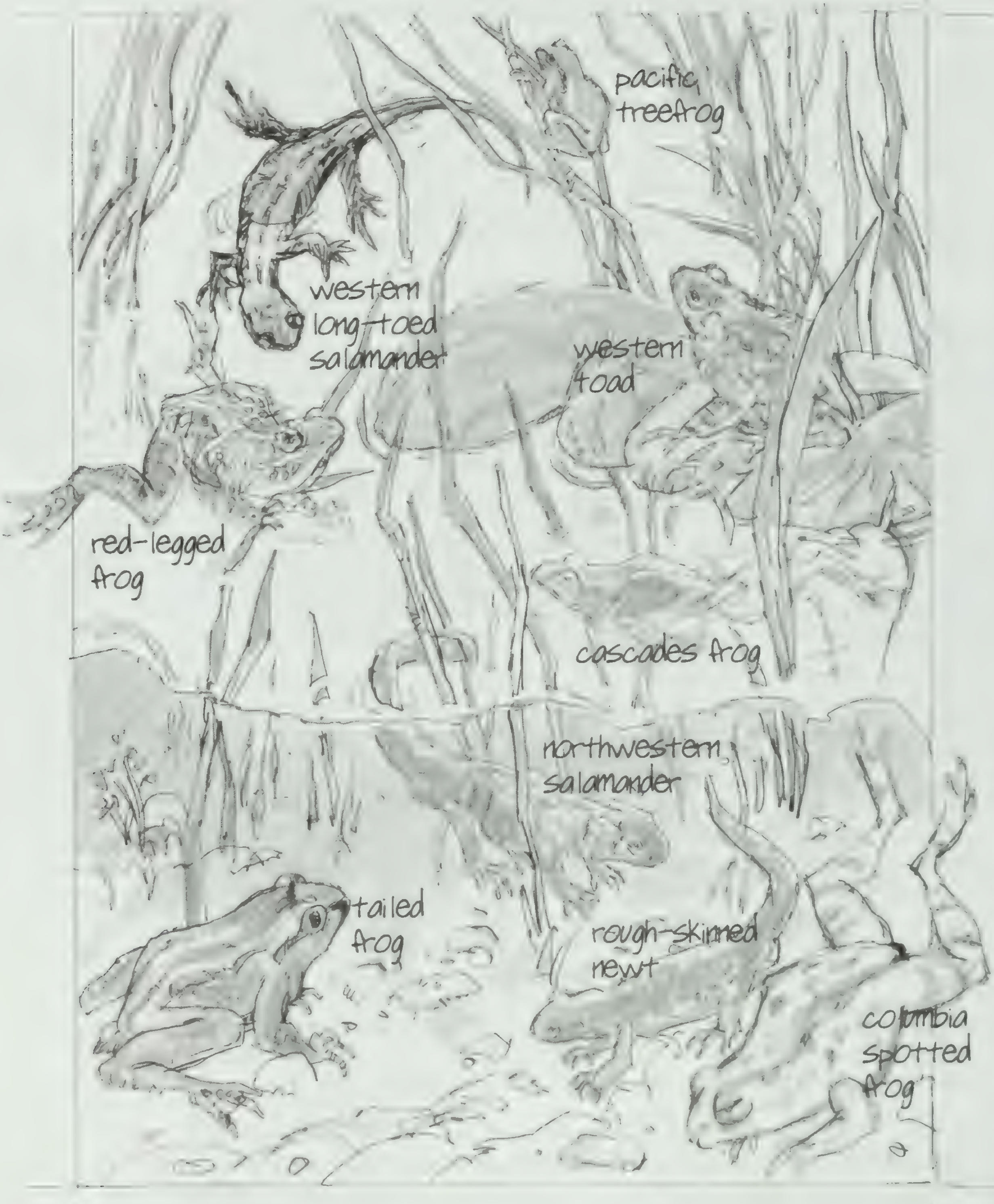
AMPHIBIANS

Of the 12 species of amphibians in the North Cascades Complex, 9 are believed to inhabit lakes and ponds or associated outlet streams and wet meadows; there are 2 species of salamander, 1 newt, 5 species of frog, and 1 species of toad. The highest diversity of amphibian species appears to be in the Big Beaver drainage on the west side of Ross Lake. This large drainage is relatively low in elevation and has an abundance of water resources such as creeks, beaver ponds, forested and scrub shrub wetlands, and seeps. The following section describes the range, habitat, and abundance (if known) of four of the amphibian species that inhabit or breed in lakes in the North Cascades Complex. Five more amphibian species are discussed under the section titled "Special Status Species" in this chapter.

LONG-TOED SALAMANDER

The long-toed salamander (*Ambystoma macrodactylum*) is widely distributed throughout the Pacific Northwest (Leonard et al. 1993) and in the North Cascades Complex (Liss et al. 1995; Bury et al. 2000). Research in the North Cascades Complex has documented larvae in a wide variety of watery habitats, ranging from shallow ponds to deep lakes. Adult long-toed salamanders are fossorial (terrestrial animals that live underground in burrows). They are not capable of creating their own burrows but depend on small mammal burrows for habitat and dispersal (Petranka 1998; Semlitsch 1983). In the fishless high-elevation mountain lakes of the North Cascades Complex, long-toed salamanders are considered the top vertebrate predator (Tyler et al. 1998a). The long-toed salamander is an important species to examine in this plan/EIS because it has been shown to be sensitive to nonnative fish predation in several studies conducted in mountain lakes in western North America (Dunham et al. 2004).

"Table G-4: Assessment of Impacts on Amphibians" (see appendix G) lists those lakes that were found to have either long-toed or Northwestern salamanders present or likely to be present, based on recent research completed in the North Cascades Complex. Of the 91 lakes in the study area, 40 are likely to have long-toed salamanders present, based on suitable habitat and known ranges, and 32 lakes have had long-toed salamander presence documented by surveys. Long-toed salamanders are found on both the west and east sides of the Cascade Crest; however, on the east side, the larvae appear to be more abundant in smaller, shallower lakes (Liss et al. 1995).

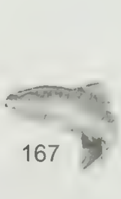

pacific treefrog
western long-toed salamander
western toad
red-legged frog
cascades frog
northwestern salamander
tailed frog
rough-skinned newt
columbia spotted frog

Two subspecies of long-toed salamanders occur in the North Cascades Complex. The distribution of the eastern long-toed salamander (*A. m. columbianum*) is east of the Cascade Crest in the Lake Chelan and Stehekin River drainages, as far upstream as the junction of Bridge Creek (including Bridge Creek to its headwaters). The western long-toed salamander (*A.m. macrodatylum*) is distributed west of the Cascade Crest in the drainages of the Skagit, Baker, and Chilliwack rivers. The western subspecies appears to be absent from much of the center of the North Unit of North Cascades National Park, and both subspecies appear to be absent in most of the South Unit, with most of the eastern long-toed salamanders documented in the Lake Chelan National Recreation Area. This distribution is consistent with long-toed salamanders recolonizing lower-gradient streams and rivers that have deep glacial sediments and avoiding the least productive lakes in the central regions of both the North and South Units.

The findings of the research conducted in the North Cascades Complex regarding effects of fish and other parameters on salamanders are summarized in the "Purpose of and Need for Action" chapter. In general, the research indicates that there are far fewer long-toed salamanders in lakes and ponds that contain fish (especially reproducing fish), compared to lakes and ponds that are fishless, although the variation in abundance can be high even within a lake. For example, recent surveys for long-toed salamanders in eight randomly selected fishless lakes found between 0 to 65 individuals per 328 feet of shoreline surveyed (Liss et al. 2002). In the early 1990s, researchers documented 2 to 170 individuals per 328 feet of shoreline at six lakes with no fish present at the time of the survey (2 had been previously stocked). In contrast, in seven lakes containing fish that were either nonreproducing stocked (2 lakes) or reproducing (5 lakes), the range was drastically lower: 0 to 8 individuals per 328 feet of shoreline surveyed. The presence of salamanders in lakes with fish may be due to their ability to persist in areas that are unfavorable or unsuitable for fish, such as in shallow areas along shorelines with rocks and woody debris where they can hide under and escape predation.

Although fish predation appears to be a primary factor affecting salamander densities in mountain lakes, there are other factors that influence the presence and abundance of larval long-toed salamanders. Some important environmental factors may include elevation, area, water depth, temperature, and certain water quality parameters (Liss et al. 1995). Another important factor is the distribution of the species within the region, especially the availability of nearby source populations that can serve to recolonize individual lakes where local populations of salamanders are no longer present.

One particular parameter that appears to be related to the abundance of long-toed salamander larvae in North Cascades Complex lakes is TKN (Tyler et al. 1998a), which is a combined measurement of ammonia and organic nitrogen. Nitrogen is a nutrient needed for production of organic matter by plants (phytoplankton and periphyton in the lakes), which are the first link in the aquatic food web and thereby, form the basis for the overall productivity of the lake. Researchers have found that the density of larval long-toed salamanders increases with increased concentration of TKN (Tyler et al. 1998a). In practical terms, this can be explained by the links in the food web. Long-toed salamander larvae feed on a variety of cladoceran zooplankton. Lakes with more nitrogen generally support



more phytoplankton, which are the food for the cladoceran zooplankton, which in turn supply more food to support larger numbers of salamanders. Therefore, lakes with high TKN and associated high productivity, especially smaller lakes that do not have fish and often not stocked, provide particularly important habitat for long-toed salamander larvae.

Very recent research into the genetic population structure of long-toed salamanders in the North Cascades Complex has uncovered a high degree of genetic diversity between local populations and populations separated by distances. Genetic isolation appears to increase with distance, and genetic exchange among separate populations is very low. This research found no significant loss of genetic diversity due to fish presence, and it underscores the importance of maintaining metapopulations by protecting lakes that are geographically isolated.

NORTHWESTERN SALAMANDER

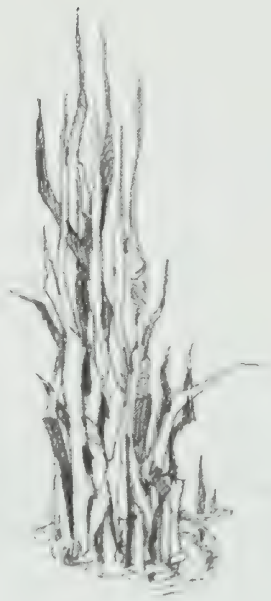
The Northwestern salamander (*Ambystoma gracile*) belongs to the same genus as the long-toed salamander. It is secretive and rarely seen except during the breeding season. Terrestrial adults, like the adults of long-toed salamanders, are fossorial and generally only come to the surface at night during rainstorms, primarily when migrating to and from breeding sites. Mountain populations are often neotenic, which means that juvenile characteristics are retained in the adult. Salamanders in this “arrested” form of development fail to change (metamorphose) from the larval form to terrestrial adults, but instead become sexually mature and reproduce while retaining larval features such as gills. Experts believe the neotenic phase may help Northwestern salamanders survive drought and other environmental stresses that often kill terrestrial salamander adults.

Unlike long-toed salamanders, which can metamorphose during their first summer in shallow temporary ponds, Northwestern salamanders require at least two years in the larval stage before metamorphosing into terrestrial adults or maturing into neotenic aquatic adults. A perennial waterbody is required for breeding and rearing of larvae and neotenic adults. Breeding female Northwestern salamanders attach large, firm egg masses to sturdy support structures, frequently attaching the egg masses 1–3 feet below the water surface (Licht 1975). In lakes or ponds that experience large fluctuations in water levels, egg masses can be exposed and then dry up or freeze, thus killing most of the developing larvae.

Some authorities recognize two subspecies of the Northwestern salamander, but the current consensus is against any subspecies divisions. The mountainous habitats of the North Cascades Complex are near the elevational range limit of the Northwestern salamander, and this may explain why they appear to be restricted to lower elevations on the west side of the Cascade Crest. Table G-4 lists those lakes where Northwestern salamanders are present, or likely to be present, based on the recent research completed in the North Cascades Complex. As can be seen in table G-4, there are eight lakes that have suitable habitat for

Northwestern salamanders, and all eight have had the presence of these salamanders documented by surveys.

Northwestern salamanders and long-toed salamanders rarely co-exist on the west side of the Cascade Crest, and long-toed salamanders appear to be excluded from larger, deeper lakes and ponds by Northwestern salamander neotenes. Northwestern salamanders typically inhabit larger, deeper lakes and ponds with plenty of coarse wood and relatively soft, flocculent (fluffy) bottoms (Hoffman et al. 2003). Northwestern salamander presence is also strongly associated with the presence of emergent vegetation (Adams et al. 2000). When Northwestern salamanders are present, the long-toed salamanders inhabit the smaller, shallower lakes and ponds with plenty of aquatic vegetation and relatively hard bottoms. Long-toed salamander breeding sites in deeper lakes in the North Cascades Complex are typically in open areas close to subalpine forest, while Northwestern salamander breeding sites typically occur in forested areas at least 1,000 feet below the treeline. In the one recorded instance of the two species occupying the same lake in the North Cascades Complex (Diobsud No. 1), Northwestern salamander larvae are the dominant species in the main body of the lake (located in subalpine forest near the treeline), with a few long-toed salamander larvae occasionally observed. Most of the long-toed salamander larvae in this lake are found in shallow pools of the outlet stream near the lake, where there are few predatory fish or Northwestern salamanders.



Emergent vegetation has roots underwater, but upper parts above the water.

All of the populations of Northwestern salamander documented in the North Cascades Complex occur in tributary lakes of the Skagit River and Ross Lake and some of the larger tributary streams. Within this limited range, Northwestern and long-toed salamander populations occur in approximately equal numbers. Although both species occur in tributaries of the Skagit River and Ross Lake, Northwestern salamanders appear to be unsuccessful in colonizing subalpine and alpine lakes and seldom occur above the low-forest zone.

Recent surveys of three lakes containing fish reported that Northwestern salamander abundance was in the range of 18 to 21 larvae per 328 feet of shoreline. These numbers are much higher than densities of long-toed salamander larvae in lakes with fish, and may indicate that Northwestern salamanders are more resistant than long-toed salamanders to fish predation. Northwestern salamanders secrete noxious chemicals when threatened, and when exposed to fish predation, they have the ability to alter their feeding behavior (for example, they shift to nocturnal feeding schedules). Also, adult Northwestern salamanders are too large for most fish to consume. These physical and behavioral adaptations may make them less susceptible than long-toed salamanders to fish predation (Liss et al. 1995).

OTHER AMPHIBIANS

Our greatest understanding of the ecological relationships between salamanders and fish in the North Cascades Complex is limited to the long-toed salamanders and Northwestern salamanders. There are, however, other amphibians in the North Cascades Complex whose life history and habitat requirements overlap with mountain lakes that contain fish and, therefore, could be affected by fishery management actions. Two species are described in this section. Several other amphibians are listed as species of concern or candidate species and are described in the section titled "Special Status Species" in this chapter.

ROUGH-SKINNED NEWT

The rough-skinned newt (*Taricha granulosa*) is the least abundant salamander in the North Cascades Complex. It has been documented in only two low-elevation lakes: Pyramid and Thunder (Liss et al. 1995). Like the Northwestern salamander, it appears to be at the limit of its eastern range in the North Cascades Complex. The skin secretions of the newt contain toxins that are extremely poisonous; for example, a healthy human adult could die from ingesting one rough-skinned newt (Leonard et al. 1993). In Mount Rainier National Park, newts have been found where fish are present, which indicates they are not particularly sensitive to fish predation (Tyler et al. 2003).

PACIFIC TREE FROG

Pacific tree frogs (*Pseudacras regilla*) are the most widely distributed frogs in the Pacific Northwest. Until recently, Pacific tree frogs were in the genus *Hyla* (tree frogs), but genetic studies have since confirmed they are actually part of the genus *Pseudacras* (chorus frogs) (Leonard et al. 1993). Taxonomists are currently split as to their correct classification. Searches under both Latin names indicate that Pacific tree frogs have been documented in at least 10 lakes and ponds that range in elevation from about 1,500 feet to 4,000 feet above mean sea level (Bury et al. 2000; Liss et al. 1995). Two of the lakes where they have been found, Willow Lake and Ridley Lake, also contain fish. These low-elevation lakes have abundant shoreline vegetation and extensive shallow areas that may allow the frogs to hide and escape fish predation. Also, the scientific literature indicates that Pacific tree frogs may be less sensitive to predation from other amphibians and introduced fish because they not only breed in permanent water bodies, but they also breed in ponds that regularly dry up (Leonard et al. 1993).

The Pacific tree frog is found in Willow Lake, which has many shallow areas with abundant shoreline vegetation.

The scientific literature varies in its findings about the effects of fish on the Pacific tree frog. Recent research on the impacts of nonnative fish on Pacific tree frogs in the Sierra Nevada Mountains suggests that Pacific tree frogs have declined significantly in areas with large numbers of stocked lakes as a result of fish predation on egg and larval stages (Matthews et al. 2001b). Conversely, other research into the ecological effects of fish on native biota in the North Cascades Complex did not document a link between fish and Pacific tree frog abundance. Two of the three low-elevation forested lakes that were studied, Willow Lake and Ridley Lake, contained both nonreproducing populations of fish and Pacific tree frogs (Liss et al. 1995), which may indicate that these frogs can adapt to or tolerate the presence of stocked fish. These lakes also have nearby refugia and breeding areas (small ponds, wetlands) that serve to support the frog populations in these lakes.

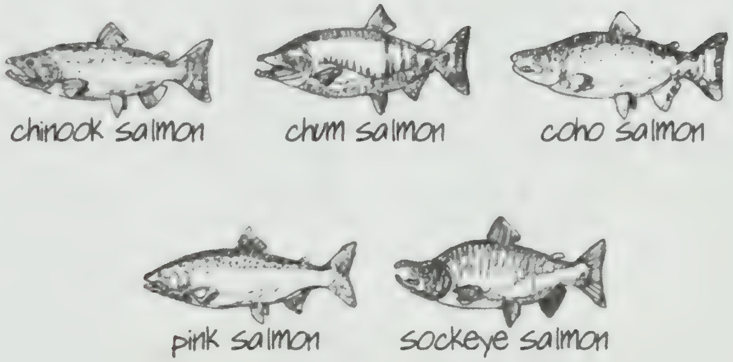
FISH

Fish in the North Cascades Complex that are addressed in this plan/EIS include two groups: (1) the native species that inhabit the mountain streams and drainages that may connect to the mountain lakes; and (2) the stocked or introduced species that are not native to the receiving lakes and that may be removed under various alternatives considered in this plan/EIS.

NATIVE FISH SPECIES

There are at least 25 native fish species that inhabit the streams and reservoirs of the North Cascades Complex (see table 18). Native fish species expected in the study area include salmon, trout, char, and mountain whitefish (family Salmonidae); minnows and dace (family Cyprinidae); suckers (family Catostomidae); sculpins (family Cottidae); and lampreys (family Petromyzontidae).

Salmon are anadromous fish, meaning they hatch in freshwater, spend a large part of their lives in the ocean, and return to freshwater to reproduce. All five Pacific salmon species (pink, sockeye, chum, Coho, and Chinook) occur in the North Cascades Complex in the Skagit River. These five species also occur in the Nooksack drainage outside the North Cascades Complex. Coho and sockeye salmon can also be found in the Chilliwack drainage in the national park. Anadromous runs of coastal cutthroat trout, bull trout, steelhead trout, and Pacific lamprey are found in the west-side drainages of the national park.



All five Pacific salmon species occur in the Skagit River within the North Cascades Complex.

Native fish populations have been affected by a variety of activities such as logging, commercial fishing, fish stocking, dams, and reservoirs. The reservoirs in the North Cascades Complex have altered and extended habitat, allowing fish migration above natural stream barriers. Prior to 1900, native anadromous and resident fish occupied primarily the low-gradient mainstream rivers and floodplain portions of their tributary streams in the North Cascades Complex. West of the Cascade Crest, native fish and char spawned and reared in steeper gradient tributaries of the mainstem rivers as far upstream as the first barrier to fish migration. In most cases these barriers were a short distance from the mainstream. In the Lake Chelan drainage, westslope cutthroat trout (*O. clarki lewisi*) were native to the Upper Stehekin River and many of its tributaries. With time, salmonid fish became established in naturally isolated tributary streams through stocking, downstream dispersal (from stocked fish populations in lakes), and from access gained by swimming around natural stream barriers when reservoirs were constructed and filled.

TABLE 18: NATIVE FISH SPECIES

Common Name	Latin Name	Native Distribution in the North Cascades Complex (Side of Cascade Crest)[a]	Basins in the North Cascades Complex[b]	Basins Downstream from the North Cascades Complex[c]
Lamprey (Petromyzontidae)				
Pacific lamprey	*Entosphenus tridentatus*	West	Skagit, Chilliwack	Nooksack, Columbia, Fraser
River lamprey[d]	*Lampetra ayresi*	West	Skagit	Nooksack, Fraser, Columbia
Western brook lamprey	*Lampetra richardsoni*	West	Skagit, Chilliwack	Nooksack, Columbia, Fraser
Sturgeon (Acipenseridae)				
White sturgeon[e]	*Acipenser transmontanus*	West[a]	Skagit	Nooksack, Columbia, Fraser
Salmon, Trout (Salmonidae)				
Pink salmon	*Oncorhynchus gorbuscha*	West	Skagit	Nooksack, Chilliwack
Chum salmon	*O. keta*	West	Skagit	Nooksack, Chilliwack, Columbia
Coho salmon	*O. kisutch*	West	Skagit, Chilliwack	Nooksack, Columbia, Fraser
Sockeye/kokanee salmon	*O. nerka*	West[b]	Skagit, Chilliwack	Columbia, Fraser
Chinook salmon[f]	*O. tshawtscha*	West[b]	Skagit	Nooksack, Chilliwack, Columbia
Coastal cutthroat trout[d]	*O. clarki clarki*	West	Skagit, Chilliwack, Nooksack	Columbia, Fraser
Westslope cutthroat trout[d]	*O. clarki lewisi*	East	Chelan	
Rainbow/steelhead trout	*O. gairdneri*	West[b]	Skagit, Chilliwack, Nooksack	Columbia, Fraser
Bull trout[g]	*Salvelinus confluentus*	West[c]	Skagit, Chilliwack	Columbia, Nooksack, Fraser
Dolly Varden	*S. malma*	West	Skagit	Nooksack, Fraser
Mountain whitefish	*Prosopium williamsoni*	West, East	Skagit, Chilliwack, Nooksack, Chelan	Fraser
Pygmy whitefish[d]	*Prosopium coulteri*	East	Chelan	
Sucker (Catostomidae)				
Longnose sucker[h]	*Catostomus catostomus*	West, East[d]	Skagit, Chelan	Nooksack, Fraser
Largescale sucker	*Catostomus macrocheilus*	West, East	Skagit, Chilliwack, Chelan	Nooksack, Fraser
Bridgelip sucker[d]	*Catostomus columbianus*	East	Chelan	
Codfish (Gadidae)				
Burbot	*Lota lota*	East	Chelan	
Sculpin (Cottidae)				
Coastrange sculpin[d]	*Cottus aleuticus*	West	Skagit, Chilliwack, Nooksack	Columbia, Fraser
Slimy sculpin	*C. cognatus*	East	Chelan	
Prickly sculpin	*C. asper*	West	Skagit, Chilliwack, Nooksack	Columbia, Fraser
Shorthead sculpin	*C. confusus*	East	Chelan	
Torrent sculpin	*C. rhotheus*	East	Chelan	

TABLE 18: NATIVE FISH SPECIES (CONTINUED)

Common Name	Latin Name	Native Distribution in the North Cascades Complex (Side of Cascade Crest)[a]	Basins in the North Cascades Complex[b]	Basins Downstream from the North Cascades Complex[c]
Minnows (Cyprinidae)				
Peamouth	*Mylocheilus caurinus*	West, East	Skagit, Chilliwack, Chelan	Nooksack, Fraser
Northern squawfish	*Ptychocheilus oregonensis*	West, East	Skagit, Chilliwack, Chelan	Nooksack, Fraser
Longnose dace[i]	*Rhinichthys cataractae*	West, East[e]	Skagit, Chelan, Nooksack	Fraser
Speckled dace[d]	*Rhinichthys osculus*	East	Chelan	
Redside shiner	*Richardsonius balteatus*	West, East	Skagit, Chilliwack, Chelan, Nooksack	Fraser
Stickleback (Gasterosteidae)				
Threespine stickleback	*Gasterosteus aculeatus*	West, East	Skagit, Chilliwack, Chelan, Nooksack	Fraser

Notes:

a. Distribution only refers to distribution within native range of species. Coastal cutthroat and rainbow that are present in the Nooksack basin within the North Cascades Complex boundaries may have been stocked but are native to watershed. Most of the Washington distributions are taken from Wydoski and Whitney (2003). Additional information on salmonid distributions is from maps in Smith (2002) and information in Cutler (2001). Additional information on distribution of fish in the Chilliwack watershed is from Scott and Crossman (1973).

b. There are four basins in the North Cascades Complex. Most of the North Cascades Complex west of the Cascade Crest is in the Skagit basin, with a small portion of the headwaters of the Nooksack River (above the range of anadromy), and portions of the upper Chilliwack River and its tributaries also occurring in the North Cascades Complex west of the Cascade Crest. The Skagit and Nooksack rivers drain into Puget Sound. The Chilliwack River drains into the Fraser River and the Straits of Georgia. All of the North Cascades Complex east of the Cascade Crest is in the Lake Chelan basin, which drains into the Columbia River.

c. This column, “Basins Downstream from the North Cascades Complex” lists areas in one of the four main basins (Nooksack, Skagit, Columbia [Chelan is a subbasin of the Columbia River], and Fraser [Chilliwack is a subbasin of the Fraser River]) downstream that have fish present that are not native to watersheds in the North Cascades Complex.

d. Represents additional species/subspecies or the common name approved by the American Fisheries Society.

e. White sturgeon do not reproduce in the Skagit River but do enter and forage in the lower (tidal portion) of the river. There are no barriers to movement in the river below Gorge Reservoir, so they may occasionally enter the portion of the Skagit River in the North Cascades Complex.

f. Chinook salmon and the landlocked form of sockeye salmon (kokanee) have been introduced into Lake Chelan but are not native to the Lake Chelan basin. Both species are native to the Columbia River above and below the confluence of the Chelan watershed with the Columbia River.

g. Bull trout are also native to the Lake Chelan basin but were gone from this watershed by the early 1960s. The U.S. Fish and Wildlife Service is considering reintroducing them.

h. Populations of longnose suckers found west of the Cascade Crest in the Fraser, Skagit, and Nooksack river watersheds are morphologically different from populations in the Columbia River basin and are reproductively isolated. These fish are referred to as Salish suckers and may represent a subspecies of longnosed suckers or undescribed species.

i. Populations of longnose dace found west of the Cascade Crest in the Fraser, Skagit, and Nooksack river watersheds are morphologically different from populations in the Columbia River basin and are reproductively isolated. These fish are referred to as Nooksack dace and may represent a subspecies of longnosed dace or undescribed species.

Hybridization: To generate a new form of plant or animal by combining the genes of two different species.

In the early 1900s, the native fish in the Stehekin River / Lake Chelan system were bull trout, cutthroat trout, burbot, and various nongame species. A number of introduced species have since become established, including rainbow trout, brook trout, kokanee salmon, Chinook salmon, and hatchery strains of cutthroat trout. Lake trout also inhabit Lake Chelan. It is believed that bull trout no longer inhabit the Stehekin River / Lake Chelan system, and native westslope cutthroat populations have been partly compromised through hybridization with rainbow trout (see the discussion under "Special Status Species" in this chapter). In addition to the Stehekin River drainage, stocked fish populations have developed in such tributaries as the North Fork Cascade River and Thunder, Fisher, Big Beaver, Newhalem, and Ruby creeks.

The distribution of native fish species in the North Cascades Complex is not fully understood. The expansion of nonnative hatchery strains may be impacting native fish populations through interbreeding or by competition and predation. Outside of the North Cascades Complex, impacts to native fish are occurring as a result of such actions as unsustainable land use practices and commercial and sport fish harvest, which have greatly reduced native populations of Chinook salmon, Coho salmon, steelhead trout, Dolly Varden, cutthroat trout, and bull trout. The abundance of discrete populations of many of these species in the North Cascades Complex boundary is currently unknown. Dolly Varden, which are very similar in appearance to bull trout (a listed species), are found only in the Thunder Creek basin (tributary to Diablo) and tributaries to the Upper Skagit River above Ross Lake, and in other tributaries to the Nooksack that are not in the national park. Dolly Varden, therefore, would not be affected by any actions in the 91 lakes that are the subject of this plan/EIS (WDFW, M. Downen, pers. comm., 2004).

Escapement Goal: The number of returning adults needed to fully use the spawning habitat.

Over the last 30 years, Skagit River salmon stocks have been considerably impacted by loss of habitat from logging, hydropower development, agriculture, estuary degradation, and nonpoint source pollution. These stocks have also been subjected to exploitation in commercial, tribal, and sport fisheries. Chinook, sockeye, and Coho salmon have been impacted the most from these activities. For example, the Coho escapement goal (a measure of how many fish must return in order to continue reproduction and sustain the fishery) is set at 30,000 and has only been attained three times in the last 27 years. The spring Chinook escapement goal of 3,000 has only been attained two times in the last 27 years. The summer run Chinook escapement goal of 15,000 fish has been attained eight times in the last 27 years. Sockeye, which are native to the Baker River drainage and are subject to intensive management efforts by several agencies, have just recently approached the escapement goal of 3,000 fish. Some of these native fish are discussed in the section titled "Special Status Species" in this chapter.

Salmon provide an important food source for many species of wildlife and a nutrient source that contributes to the biological productivity of both aquatic and terrestrial ecosystems. The Skagit River's 300 to 500 wintering bald eagles depend largely on salmon as a food source.

NONNATIVE FISH IN MOUNTAIN LAKES

Over the years, several trout species and subspecies have been stocked in lakes in the North Cascades Complex, and six of these have become established as reproducing populations.

California golden trout (*Oncorhynchus mykiss aguabonita*)

Coastal cutthroat trout (*Oncorhynchus clarki clarki*)

Westslope cutthroat trout (*Oncorhynchus clarki lewisi*)

Rainbow trout (*Oncorhynchus mykiss*)

Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*)

Brook trout (*Salvelinus fontinalis*)

The Yellowstone cutthroat trout and brook trout are not considered in this plan/EIS for future stocking because neither fish is native to the area. Also, brook trout tend to overpopulate lakes in which they are stocked because of their ability to spawn successfully on lake bottoms, not just in the gravel bottoms of outlet or inlet streams (Behnke 2002). Brook trout have been stocked in at least four lakes in the North Cascades Complex over the years and have survived as reproducing populations in three lakes: Blum (Lower/West No. 4), Hozomeen, and Sourdough. Brook trout in Hozomeen Lake are known to be dispersing downstream into native bull trout habitat, although hybridization has not yet been documented. Ipsoot Lake has the only remaining reproducing population of Yellowstone cutthroat trout.

Research into the ecological impacts of nonnative fish has demonstrated that high densities of reproducing stocked fish have the greatest impacts on native species (Liss et al. 2002; Tyler et al. 1998a, b). High densities of fish can result from excessive stocking densities or from natural reproduction when conditions are suitable for spawning (such as the presence of inlets and streams). There are 37 lakes in the North Cascades Complex with reproducing populations of stocked fish, primarily various strains of rainbow and cutthroat trout. In most of these lakes, the stocked fish have the ability to dominate many trophic levels and have developed high densities.

Table 6 in the “Alternatives” chapter lists the 62 lakes in the North Cascades Complex managed by the Washington Department of Fish and Wildlife (WDFW) that are known to contain fish, the reproducing fish species currently present in 35 of these lakes, and the species and strains of fish to be stocked under one of the proposed new management frameworks presented in the “Alternatives” chapter. A description of the species and strains of fish in the current stocking program is provided in the following sections.

California Golden Trout

All California golden trout outside of California are derived from a single population in Golden Trout Creek in the upper Kern River drainage and transplanted around 1872 to Mulkey Creek, a tributary of the South Fork of the Kern River (Behnke 2002). The California golden trout (*O. mykiss aquabonita*), along with Little Kern River golden trout (*O. mykiss whitei*) and Kern River rainbow trout (*O. mykiss gilberti*), is one of three closely related subspecies of redband rainbow trout native to the Kern River basin of California (Behnke 2002). California golden trout are occasionally confused with Mexican golden trout (*O. chrysogaster*), a separate species, and West Virginia centennial golden trout, a highly colored hatchery strain of rainbow trout (*O. mykiss*). Neither of these fish is stocked in Washington. California golden trout are known to have been stocked in six lakes in the North Cascades Complex in the past, and California golden trout are on the current stocking list for four lakes: Middle Thornton, Triumph, Upper Bouck, and Hidden.

California golden trout exhibit excellent growth and survival in mountain lake habitat, and in Washington, they tend not to reproduce excessively or disperse downstream from mountain lakes. Golden trout can successfully reproduce in lakes in Washington State, but reproduction levels are not high enough to sustain populations without periodic stocking (WDFW 2001). In addition, their beautiful and distinctive coloration makes them highly sought after by anglers.

Coastal Cutthroat Trout (Lake Whatcom Strain)

Coastal cutthroat trout are native throughout many Pacific Coast drainages from Prince William Sound, Alaska, to the Eel River in northern California, including on the west side of the Cascade Crest in the study area. Interior strains of cutthroat trout are preferred by many fishery biologists for stocking mountain lakes because of their ability to survive and grow rapidly in cold, short, ice-free seasons and low-nutrient environments. Currently, the Lake Whatcom strain of cutthroat trout is being stocked. This is a hatchery strain of coastal cutthroat trout (*Oncorhynchus clarki clarki*) that originated from broodstock collected in Whatcom Lake, Washington. The broodstock is currently being maintained at the Eells Springs Hatchery where eggs are collected and fertilized for shipments to local hatcheries for hatching and rearing, prior to stocking in mountain lakes. This strain of coastal cutthroat trout is currently on the proposed stocking list for four lakes: Copper, Panther Potholes (Lower), Willow, and Stout.

A Lake Whatcom strain of cutthroat trout is stocked in Willow Lake.

Lake Whatcom strain coastal cutthroat trout were selected to diversify the fishing opportunity for mountain lake anglers and add a variety of fish that are native to the Skagit River drainage. They are also proposed for stocking in Stout Lake, which has a nonnative reproducing population of westslope cutthroat trout, in the hope that they would replace, in time, the westslope cutthroat trout population or reduce the proportion of westslope cutthroat genes in the reproducing population, thereby producing a stock of fish with the phenotype of coastal cutthroat trout (WDFW 2003).

Westslope Cutthroat Trout (Twin Lakes)

Twin Lakes cutthroat trout are a wild broodstock of westslope cutthroat trout (*O. clarki lewisi*) proposed for stocking at Coon Lake. This stock of cutthroat is currently hatched and reared at the WDFW Chelan Hatchery for stocking in several North Cascades Complex lakes within the Lake Chelan drainage where westslope cutthroat trout are native. It is unclear when these lakes were first stocked with westslope cutthroat trout (Crawford 1979).

The common name for this subspecies in scientific literature is "westslope cutthroat trout," and this is the common name used in most literature and by the U.S. Fish and Wildlife Service in referring to this subspecies. This name was applied because it was originally believed to be native only to the west side of the Rocky Mountains. It is also referred to as "intermountain cutthroat" (WDFW 2003) because it is typically found between the crest of the Cascades and the crest of the Rockies. This subspecies, however, is also the native cutthroat trout of the east side of the Rocky Mountains north of the Yellowstone River drainage (Behnke 1992).

Rainbow Trout (Ross Lake and Mt. Whitney Strains)

Rainbow trout have a native range along the Pacific slope from the Kuskokwim River, Alaska; to approximately the Rio Santa Domingo, Baja California; and east to the upper Mackenzie River drainage (Arctic Basin), Alberta and British Columbia; and lower-elevation basins of southern Oregon (Page and Burr 1991; Behnke 2002). Rainbow trout are native to the lower elevations on the west side portions of the North Cascades, but not to the mountain lakes. There are many varieties of rainbow trout, and various hatchery strains have been stocked in a large number of lakes in the North Cascades Complex.

Ross Lake Strain—The Ross Lake strain of rainbow trout is a natural stock of resident (nonmigratory or non-anadromous) coastal rainbow trout *(O. m. irideus)* native to the upper Skagit River watershed (Ross Lake subbasin). Eggs and milt are stripped from Ross Lake rainbows at tributaries of Ross Lake and hatched and reared at the Marblemount Hatchery for stocking into the upper Skagit River basin. The Ross Lake broodstock program is mainly intended to maintain a reservoir fishery in Gorge and Diablo lakes (which are not part of the study area for this plan/EIS), but Ross Lake rainbows are also proposed for stocking into Ridley Lake, which drains into Ross Lake. Although Ross Lake rainbows are capable of reproducing in a natural environment, they are not known to be able to reproduce in Ridley Lake due to an absence of graveled tributaries, and any fish that escape downstream would be populating a basin where they are already native.

Mt. Whitney Strain—Mt. Whitney rainbow trout are designated as the proposed species to be stocked in 32 of the 38 lakes in the current program (refer to table 6 in the "Alternatives" chapter). These fish are a hatchery strain of rainbow trout originally developed at the Mt. Whitney Hatchery (California) from several subspecies of rainbow native to the state of California. Coastal (*Oncorhynchus mykiss irideus*), Sacramento River (*O. m. stonei*), and Kern River (*O. m. gilberti*) rainbow trout broodstock are likely to have been used to develop this hatchery strain of rainbow trout, and it is possible that broodstock from the Kamloops *(O. m. gairdneri)* and Klamath River (*O. m. newberrii)* rainbow trout may have contributed to its genetic makeup. Lahontan cutthroat trout *(O. clarki henshawi*) broodstock also were crossed with this stock before it was obtained from the Mt. Whitney Hatchery.

The Washington State broodstock for Mt. Whitney rainbows, currently stocked on both sides of the North Cascades, is currently housed at the Eells Springs Hatchery near Shelton, Washington, where all eggs are taken. Eggs or fry are dispersed from Eells Springs to various local hatcheries to supply fry for stocking in high lakes. The Washington broodstock was founded from a shipment of eggs obtained from the Mt. Whitney hatchery at Independence, California, in June 1962 (Crawford 1979). The Mt. Whitney hatchery strain was originally developed at the Mt. Whitney hatchery in 1940, and eggs from the original California broodstock were shipped to Washington hatcheries for planting in mountain lakes as early as 1946 (Crawford 1979; WDFW 2001). This hatchery strain of rainbow trout is currently the preferred choice of the WDFW for stocking mountain lakes because it has never been documented to reproduce in mountain lakes of Washington State (WDFW 2001). This is likely because the timing of their breeding season is too early to successfully spawn in mountain lakes (the majority of spawners become ripe in January). The nonreproductive nature of Mt. Whitney rainbows in a mountain lake environment eliminates the risk of stocked mountain lakes becoming overpopulated with stunted rainbow trout. Mt. Whitney rainbows also exhibit excellent growth and survival in mountain lake habitat and produce fry at an appropriate time for stocking in mountain lakes during their ice-free period. Other hatchery rainbow stocks (with the exception of anadromous steelhead) maintained by the WDFW are fall spawners.

Haplotype: A set of closely linked genes inherited as a unit. "Haplo" comes from the Greek word for "single."

Mt. Whitney rainbows do have the potential to reproduce in lower-elevation streams but have not been documented to establish populations from fish stocked into mountain lakes in Washington State. The haplotype of Mt. Whitney rainbow has been found in low frequency during surveys of Yellowjacket Creek, a tributary of the Cowlitz River in Washington, but no mountain lakes exist in the stream's basin (Trotter et al. 1995). Mt. Whitney rainbows are stocked in low-elevation, off-channel ponds (Yellowjacket Ponds) about a half-mile upstream from the survey collection site as "super jumbo" catchable trout. Since the Mt. Whitney rainbow haplotype was found in typical small stream trout sampled in Yellowjacket Creek (rather than "super jumbo" sized fish), it is likely that introgression between stream-resident rainbow trout and escapees from hatchery stocks of Mt. Whitney rainbows accounts for the presence of the Mt. Whitney haplotype in Yellowjacket Creek rainbow trout. Measurable introgression between Mt. Whitney rainbow trout stocked in mountain lakes and low-elevation stream population of rainbow and cutthroat trout would probably require the colonization of higher-elevation reaches of lake outlet streams, an unlikely event considering the early spawning of Mt. Whitney rainbows. Although individual Mt. Whitney rainbows may occasionally escape mountain lakes where they have been stocked and make it far enough downstream to have suitable spawning habitat during the winter months, the level of genetic contribution to native fish populations is likely to be so slight as to be unmeasurable.

WILDLIFE

All species of terrestrial wildlife in the North Cascades Complex depend on water for various reasons and to different degrees, but only a small fraction of all wildlife species have strong links to the mountain lakes fishery or would be impacted by mountain lakes fishery management activities. This section describes a variety of birds and mammals that inhabit the forests, streams, wetlands, and meadows surrounding the mountain lakes that could be directly or indirectly affected by changes in mountain lakes fishery management actions, including changing stocking regimes, discontinuing stocking altogether, or removing fish using one of the lake treatment methods described in the "Alternatives" chapter. Many other wildlife species inhabit the North Cascades Complex but are intentionally not discussed here because they would unlikely incur impacts from fishery management activities, do not generally inhabit areas near mountain lakes, or do not depend on aquatic resources.

MAMMALS

Mule deer (*Odocoileus hemionus*) are the most numerous ungulates in the North Cascades Complex, including the blacktail subspecies, which occurs west of the Cascade Crest. Elk (*Cervus elaphus*) and moose (*Alces alces*) inhabit the North Cascades Complex in smaller numbers, though both species are considered rare visitors. It is estimated that 100–330 mountain goats (*Oreamnos americanus*) inhabit the higher elevations in the North Cascades Complex, and its populations are declining. The rate of mountain goat mortality is unknown; it is known, however, that mortalities are due to avalanches, falls, and predation (by mountain lions or golden eagles, for example), as well as stress and parasites due to extreme winter conditions.

Although well-adapted for life in rugged terrain and harsh climates, mountain goat populations are declining.

Black bears and grizzly bears inhabit the North Cascades Complex. Black bears (*Ursus americanus*) are common, but grizzlies (*Ursus arctos*) are extremely rare and unlikely to be affected by fishery management actions. Grizzly bears are a federally listed species and are addressed in the section titled "Special Status Species" in this chapter. Black bears are omnivores and eat any kind of food (plant or animal), including fish, if the opportunity presents itself. The extent to which black bears rely on fish in mountain lakes has not been studied but is thought to be rare, though they are known to feed on spawning fish in inlet or outlet streams. During one unusual instance in the mid-1990s, Willow Lake nearly dried up during an extended summer drought. The stocked fish in the lake died, and within a few days, several black bears were seen feeding on the fish carcasses.

Bobcats (*Felis rufus*) are elusive yet common in broken, rocky mountainous areas, as well as hardwood and coniferous forest. The diet of bobcats generally consists of small mammals and birds (Larrison 1976). Canada lynx (*Lynx* *canadensis*) are known to occupy areas east of the North Cascades Complex and are discussed in the section titled "Special Status Species" in this chapter.

Cyprinids: Freshwater fish of the family that includes carp and minnows, typically with rounded scales, soft fins, and toothless jaws.

Coyotes (*Canis latrans*) occupy virtually all natural habitats, but are less common in subalpine and alpine habitats (Larrison 1976). Red foxes (*Vulpes vulpes)* inhabit foothills and mountains and eat mice, insects, birds, amphibians, and reptiles.

River otters (*Lutra canadensis*) prefer low-elevation, forested habitat in rivers, ponds, and lakes, so potential habitat in the North Cascades Complex is fairly widespread. Otters are documented in many drainages throughout the North Cascades Complex, including Little Beaver Creek drainage. Otters are known to feed on game fish, such as trout, but they appear to prefer slower-moving fish such as suckers and larger cyprinids (Whitaker 1980).

Beavers (*Castor canadensis*) are widely distributed at lower elevations in the North Cascades Complex, particularly in the Big Beaver, Stehekin, Thunder, and Little Beaver valleys. Beavers eat bark, not fish (Whitaker 1980) and, therefore, have an indirect ecological relationship to stocked fish in that they create or augment water bodies at lower elevations, and these habitats often benefit a wide variety of other wildlife, including stocked and native fish.

Twelve species of bats may occur in the Cascade Mountain Range of Washington. The most common species to inhabit the North Cascades Complex are Yuma myotis (*Myotis yumanensis*) and little brown myotis (*M. lucifugus*) (Christophersen and Kuntz 2003). Long-eared bat (*Myotis evotis*) and long-legged bat (*M. volans*) have also been documented in the North Cascades Complex. Long-eared bats are most common in low- to mid-elevation forested habitats, and long-legged bats are rarely captured, with only one capture occurring in low- to mid-elevation riparian habitats (Christophersen and Kuntz 2003). Yuma myotis and long-eared bats are considered species of special concern that are most likely to occur near high mountain lakes and are discussed further in the "Special Status Species" section in this chapter. Additionally, nonlisted bat species that are closely associated with old-growth forests in the Pacific Northwest include California myotis (*Myotis californicus*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cinereus*) (NPS 1999a).

BIRDS

RAPTORS

Ospreys (*Pandion haliaetus*) are breeding residents in the North Cascades Complex, with nest sites located on Ross Lake, Diablo Lake, Lake Chelan, Thunder Creek, and the Skagit River. While some of these nests are not actively used every year, others are used annually (NPS, B. Kuntz, pers. comm., 2004). Ospreys have been observed feeding on fish at Thornton, McAlester, and Monogram lakes. The osprey at Thornton Lake may have been from the breeding pair along the Skagit River (NPS, R. Christophersen, pers. comm., 2003). The extent to which ospreys depend on the mountain lakes fishery is not known but could be quite substantial given the relatively easy opportunity to catch fish.

Red-tailed hawks (*Buteo jamaicensis*), northern harriers (*Circus cyanus*), great-horned owl (*Bubo virginianus*), barred owl (*Strix varia*), and Western screech owl (*Otus kennicottii*) inhabit the North Cascades Complex and may potentially nest in trees near the lakes. Northern goshawks (*Accipiter gentilis*) are a federal species of concern that also may nest near lakes in the North Cascades Complex; they are discussed further in the "Special Status Species" section in this chapter. Sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), golden eagle (*Aquila chrysaetos*), merlin (*Falco columbarius*), and peregrine falcons (*Falco peregrinus*) occur in the North Cascades Complex but are not directly associated with lake habitats.

Monogram Lake is one of the few lakes in the North Cascades Complex where ospreys have been observed.

Wintering bald eagles (*Haliaeetus leucocephalus*) are frequently observed in lower-elevation lakes. The bald eagle is a federally listed species and is further addressed in the "Special Status Species" section in this chapter.

WATERFOWL

Many species of waterfowl, such as ducks and geese, occupy the North Cascades Complex seasonally or in migration, but only a few of these species nest in the North Cascades Complex. Harlequin ducks are a federal species of concern that nest in the North Cascades Complex, and common loons are a sensitive species in the state of Washington; both species are discussed further in the section titled "Special Status Species" in this chapter.

Two fish-eating ducks, the common merganser (*Mergus merganser*) and hooded merganser (*Lophodytes cucullatus*), nest in and inhabit the wetlands, open water, and riverine habitats in the North Cascades Complex. Both species have been observed on Coon Lake, and common mergansers are also seen frequently along the Stehekin and Skagit rivers. There are no records of these two ducks occurring near any of the mountain lakes in the study area, although it is certainly possible that they could feed on fish in the summer months, particularly at the lower-elevation lakes.

Another duck species, Barrow's goldeneye (*Bucephala islandica*), inhabits lakes and ponds larger than two acres in high-elevation montane habitats. Barrow's goldeneye requires tree cavities for nesting, usually within 100 feet of open water. The species primarily eats insects, crayfish, some fish, blue mussels, pondweeds, and wild celery.

Mallard ducks (*Anas platyrhnchos*), wood ducks (*Aix sponsa*), and Canada geese (*Branta canadensis*) are known to nest around lakeshores in the North Cascades Complex. Wood Ducks have been observed at Coon Lake and Thunder Lake. Canada Geese nest most commonly near the head of Lake Chelan, along the shores of all the reservoirs in the North Cascades Complex, and along the lower 2–3 miles of the Stehekin River (NPS, B. Kuntz, pers. comm., 2004).

PASSERINES

Many species of songbirds are residents or nest in the North Cascades Complex and occupy areas near lake, riparian, or wetland habitats such as those found adjacent to lakes and streams. Birds known to occur in the North Cascades Complex that are dependent on riparian or lake habitats for shoreline nesting or foraging habitat are shown in table 19 (NPS 2003b).

REPTILES AND AMPHIBIANS

The common garter snake (*Thamnophis sirtalis*) and terrestrial garter snake (*T. elegans*) are found in the North Cascades Complex, but there is little information on their abundance and distribution. The terrestrial garter snake inhabits the Puget Sound trough and the east side of the Cascade Crest up to 3,000 feet in elevation. The common garter snake is abundant on both sides of the Cascades. It is found up to 2,000 feet in elevation in the Skagit River drainage and up to 4,000 feet in the Bridge Creek drainage. Both species are commonly associated with water, including ponds, wet meadows, and lakes. The terrestrial garter snake can also be found in low-elevation forests (Dvornich et al. 1997).

The common and terrestrial garter snakes consume a wide variety of prey, including invertebrates, small mammals, and amphibians. Both species are known to feed heavily on amphibians, even species such as the Western toad and rough-skinned newt that are considered unpalatable to highly toxic for most other predators. In high-elevation lakes in the Sierra Nevada Mountains, researchers have found that amphibian presence is an important biological factor in the persistence of the mountain garter snake (Matthews et al. 2001a). There are no studies, however, that document garter snake dependence on amphibians in mountain lakes in the North Cascades Complex.

Five amphibians in the North Cascades Complex are federally listed as species of concern as defined by the U.S. Fish and Wildlife Service: Cascades frog, Columbia spotted frog, tailed frog, northern red-legged frog, and Western toad. These species are discussed further in the section titled "Special Status Species" in this chapter. Other amphibian species were discussed earlier in the "Aquatic Organisms" section.

TABLE 19: PASSERINE BIRDS THAT UTILIZE RIPARIAN AREAS IN THE NORTH CASCADES COMPLEX

Common Name	Scientific Name	Common Name	Scientific Name
American dipper	*Cinclus mexicanus*	Olive-sided flycatcher	*Contopus cooperi*
Barn swallow	*Hirundo rustica*	Red-winged blackbird	*Agelaius phoeniceus*
Belted kingfisher	*Ceryle alcyon*	Swainson's thrush	*Catharus ustulatus*
Cliff swallow	*Petrochelidon pyrrhonota*	Tree swallow	*Tachycineta bicolor*
Dusky flycatcher	*Empidonax oberholseri*	Violet-green swallow	*Tachycineta thalassina*
Hammond's flycatcher	*Empidonax hammondii*	Warbling vireo	*Vireo gilvus*
Killdeer	*Charadrius vociferous*	Wilson's warbler	*Wilsonia pusilla*
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Little willow flycatcher	*Empidonax traillii brewsterii*

SPECIAL STATUS SPECIES

For the purposes of this plan/EIS, "special status species" are defined as those listed by either the U.S. Fish and Wildlife Service as endangered, threatened, candidate, or special concern; or by the state of Washington as endangered, threatened, candidate, or a sensitive species. The terms "threatened" and "endangered" generally describe the official federal status of vulnerable species in the North Cascades Complex, as defined by the *Endangered Species Act of 1973*. The term "candidate" is used officially by the U.S. Fish and Wildlife Service when describing those species for which sufficient information on biological vulnerability and threats is available to support issuance of a proposed rule to list, but rule issuance is precluded for some reason. The federal "species of concern" status is applied to those species for which listing may be warranted, but further biological research and field study are needed to clarify their conservation status.

For Washington state-listed species, animals are categorized as threatened, endangered, candidate, or sensitive by the WDFW. Rare plants are listed in one of six categories (endangered, threatened, sensitive, possibly extirpated [no longer present], review status, or watch status) by the Washington Natural Heritage Program. *NPS Management Policies* dictate that federal candidate species, species of concern, and state-listed threatened, endangered, candidate, or sensitive species be managed to the greatest extent possible as federally listed threatened or endangered species (NPS 2001a). Therefore, all of these special status species are included in this discussion.

FEDERALLY LISTED SPECIES

A consultation letter was sent to the U.S. Fish and Wildlife Service, and a reply was received on August 15, 2003 (included in appendix C). The reply included county-based listings of federally listed species in the North Cascades Complex. Based on this broad information and input from North Cascades Complex biologists, a list of those special status fish and wildlife species that could possibly occur within the boundaries of the North Cascades Complex was prepared (see appendix C, table C-1). This list was then narrowed down further to a list of those special status species that would be expected in or near lakes or in nearby forests within the study area that could be affected by actions proposed in the various alternatives. These species are listed in table 20.

There are no known species of federally listed plants in the North Cascades Complex.

CALIFORNIA WOLVERINE (FEDERAL SPECIES OF CONCERN, STATE CANDIDATE)

Wolverines are nocturnal and solitary and historically occurred in low densities. They occupy boreal forests (forests with northern temperate climates) and tundra habitats. Wolverines eat a variety of prey, including fish, but they do not rely on fish as a sole source of food. Their population size, distribution, or abundance in the North Cascades Complex is unknown.

TABLE 20: FEDERALLY LISTED SPECIAL STATUS SPECIES POTENTIALLY OCCURRING IN THE NORTH CASCADES COMPLEX

Common Name	Scientific Name	Species Status	
		Federal	State
California wolverine	*Gulo gulo luteus*	Species of Concern	Candidate
Canada lynx	*Lynx canadensis*	Threatened	Threatened
Gray wolf	*Canis lupus*	Endangered	Endangered
Grizzly bear	*Ursus arctos*	Threatened	Endangered
Pacific fisher	*Martes pennanti*	Species of Concern	Endangered
Yuma myotis (bat)	*Myotis yumanensis*	Species of Concern	
Long-eared bat	*Myotis evotis*	Species of Concern	
American peregrine falcon	*Falco peregrinus anatum*	Species of Concern	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened
Harlequin duck	*Histrionicus histrionicus*	Species of Concern	
Marbled murrelet	*Brachyramphus marmoratus*	Threatened	Threatened
Northern spotted owl	*Strix occidentalis caurina*	Threatened	Endangered
Northern goshawk	*Accipiter gentilis*	Species of Concern	Candidate
Little willow flycatcher	*Empidonax traillii brewsterii*	Species of Concern	
Olive-sided flycatcher	*Contopus borealis*	Species of Concern	
Cascades frog	*Rana cascadae*	Species of Concern	
Columbia spotted frog	*Rana luteiventris*	Species of Concern	Candidate
Northern red-legged frog	*Rana aurora aurora*	Species of Concern	
Tailed frog	*Ascaphus truei*	Species of Concern	
Western toad	*Bufo boreas*	Species of Concern	Candidate
Bull trout	*Salvelinus confluentus*	Threatened	Candidate
Chinook salmon	*Oncorhynchus tshawtscha*	Threatened	
Coho salmon	*Oncorhynchus kisutch*	Candidate	Sensitive
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	Species of Concern	

CANADA LYNX (FEDERAL THREATENED, STATE THREATENED)

Canada lynx occupy contiguous areas of spruce/fir forests. Although Canada lynx have only been documented in areas east of the North Cascades Complex, it does contain suitable habitat for the species, and therefore, lynx are likely present in the North Cascades Complex; however, lynx do not depend on fish as a source of food.

Small numbers of gray wolves may be present in the North Cascades Complex.

GRAY WOLF (FEDERAL ENDANGERED, STATE ENDANGERED)

Gray wolves occupy forested and open habitats away from human development and use. Gray wolves have been observed in several locations in the North Cascades Complex, but not since 1993. Nonetheless, wolves are likely present in the North Cascades Complex in small numbers, though that number is unknown. Gray wolves may eat fish opportunistically.

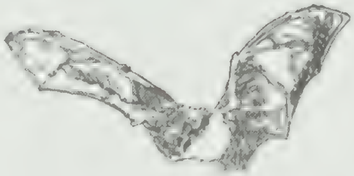
GRIZZLY BEAR
(FEDERAL THREATENED, STATE ENDANGERED)

The status of the grizzly bear is unknown in the North Cascades Complex, but based on the suitability of the habitat, grizzly bears inhabit the North Cascades Complex in small numbers (NPS, R. Zipp, pers. comm., 2003). Grizzly bears are omnivores, but they occasionally eat vegetation or scavenge trash and may eat fish opportunistically.

PACIFIC FISHER (FEDERAL SPECIES OF CONCERN, STATE ENDANGERED)

Pacific fishers are rare nocturnal carnivores that have historically occurred throughout Washington in large contiguous areas of undisturbed forested habitats at elevations below 6,000 feet. The fisher's primary prey are porcupine and snowshoe hare, although they do eat smaller mammals such as shrew, squirrel, muskrat, and beaver, as well as carrion and fruit. They den in tree cavities, rotten logs, and rocky crevices.

The WDFW does not believe a viable Pacific fisher population exists in Washington, and soon, the species may no longer occur in the state (Lewis and Stinson 1998). In 1991 the U.S. Forest Service conducted extensive line-triggered camera surveys in the North Cascades, among other sites, and documented no evidence of Pacific fishers. Currently, the NPS at the North Cascades Complex is conducting a Forest Carnivore Inventory (2003-2004), and at the time of writing, no Pacific fishers have been documented (NPS, B. Kuntz, pers. comm., 2004). Several recent observations in the Bridge Creek drainage suggests that Pacific fishers could potentially be present in the North Cascades Complex in very small numbers, although that number is unknown because the species is solitary and elusive, generally avoiding large open areas.


Yuma Myotis usually flies close to the water's surface, foraging on moths and small insects such as caddisflies and midges.

YUMA MYOTIS
(FEDERAL SPECIES OF CONCERN)

Yuma myotis is a small insect-eating bat that is closely associated with water. In a recent field survey, Yuma myotis was the most frequently captured bat species, with the majority of captures occurring in low- to mid-elevation riparian habitats (Christophersen and Kuntz 2003). The ecological relationship between introduced fish and this small bat is indirect, since both species feed on a similar food base of aquatic and terrestrial insects along riparian areas.

LONG-EARED BAT
(FEDERAL SPECIES OF CONCERN)

Long-eared bats are insectivores and primarily inhabit mid- to low-elevation coniferous forests, but they have been captured at high-elevation sites (Bats Northwest 2004). The bats day roost in sheltered areas such as tree cavities under loose bark and rock crevices and also use these sites, as well as caves and mines, for night roosts (USGS 1995). These bats prey on insects such as beetles, moths, and flies that are gleaned from leaves in dense vegetation, but long-eared bats

also forage over water (USGS 1995; Bats Northwest 2004). The U.S. Fish and Wildlife Service lists long-eared bats as a “Species of Concern” due to the lack of information on both hibernation and reproductive biology (Bats Northwest 2004).

Like Yuma myotis, long-eared bats do not have a direct ecological association with stocked lake fish. Furthermore, while long-eared bats are known to forage over water, they do not depend on aquatic habitats to catch their prey.

AMERICAN PEREGRINE FALCON (FEDERAL SPECIES OF CONCERN, STATE ENDANGERED)

Peregrine falcons occur in a variety of habitats and usually nest on cliffs in the North Cascades Complex. This raptor hunts medium-sized birds (including waterfowl) in open areas. Once listed as endangered, peregrine falcon populations have rebounded, primarily because of the ban on the use of DDT (dichlorodiphenyltrichloroethane).

BALD EAGLE (FEDERAL THREATENED)

Bald eagles primarily inhabit low-elevation riparian areas in the North Cascades Complex and have a direct ecological relationship to stocked fish. Eagles typically time their arrival to the North Cascades Complex to coincide with the fall and winter salmon runs along the Skagit River. Usually by mid-November, the Skagit River hosts 300 to 500 eagles, one of the largest wintering concentrations of bald eagles in Washington State (NPS 1999a). Monitoring records over the past 16 years show that wintering eagle populations were increasing, but recently, it appears that eagle populations may have stabilized.

A bald eagle pair has nested near the mouth of the Stehekin River since 2001, and a pair of bald eagles has been seen foraging on Ross Lake during the breeding season. Just over 1 mile west of the North Cascades Complex boundary, a bald eagle pair has nested successfully for at least the past 10 years. The extent to which bald eagles hunt for fish in mountain lakes is unknown; they most likely limit their foraging to lower-elevation lakes with long ice-free periods.

HARLEQUIN DUCK (FEDERAL SPECIES OF CONCERN)

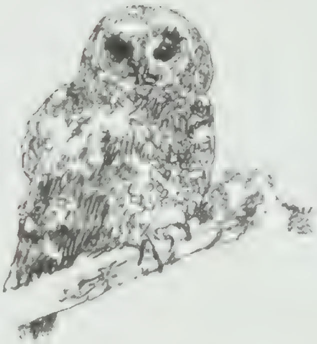
Harlequin ducks are small diving ducks that feed primarily on aquatic invertebrates in low-gradient creeks and streams, but they also consume fish (Gough et al. 1998). These ducks are summer residents that nest on the rocky shores of low-gradient (less than 5% slopes) creeks and streams in the North Cascades Complex. Harlequin ducks arrive in early to mid-April. The males leave in late June to molt, while females and young remain through September before migrating back to the coast. The distribution of harlequins is fairly broad, and the species occurs throughout the North Cascades Complex, including the tributaries of the Skagit and Stehekin rivers. Even though they are not directly associated with mountain lakes, they may opportunistically feed on fry swimming downstream from lakes containing stocked fish.

MARBLED MURRELET (FEDERAL THREATENED, STATE THREATENED)

Marbled murrelets are small birds that winter on the Pacific Ocean and nest up to about 50 miles inland in old-growth forests in the Pacific United States. Murrelets return to the coast early in the morning to forage and return to the nest in the evening to feed their young. There have been observations of marbled murrelets near the west boundary of the North Cascades Complex, but no marbled murrelets have been documented in the North Cascades Complex. The marbled murrelet is listed as threatened at the federal and state level due to fragmentation and loss of old-growth forest nesting habitat and mortality from capture in salmon gillnets while foraging in the ocean.

NORTHERN SPOTTED OWL (FEDERAL THREATENED, STATE ENDANGERED)

The northern spotted owl inhabits mainly old-growth forests in the Pacific United States but also utilizes a variety of other forest types. In Washington, spotted owls primarily prey on flying squirrels, woodrats, and red tree voles (NPS, B. Kuntz, pers. comm., 2004). Approximately 20 breeding pairs of spotted owls occur in the North Cascades Complex. At least one spotted owl nest has been located within 1 mile of a lake considered in this plan/EIS, but the majority of lakes included in this plan/EIS are outside the elevational range of the northern spotted owl. The northern spotted owl is listed as endangered in the state of Washington because of extensive loss of habitat.



Northern spotted owls nest in hollowed-out cavities of very old trees. They feed on a variety of rodents.

NORTHERN GOSHAWK (FEDERAL SPECIES OF CONCERN)

Northern goshawks generally nest within about 650 to 980 feet of permanent water sources. They occur in mid- to high-elevation mature forests but usually prefer to nest in lower-elevation forests (Desimone and Hays 2004; Smith et al. 1997). The NPS has not documented northern goshawk nests near study area lakes, though pairs have been observed and may nest in areas near Dagger Lake (NPS, R. Zipp, pers. comm., 2004). Goshawks would more likely be found nesting near lower-elevation lakes within forested habitat. Northern goshawks are a federal species of concern due to loss of habitat.

LITTLE WILLOW FLYCATCHER (FEDERAL SPECIES OF CONCERN)

The little willow flycatcher is a subspecies of the willow flycatcher. The subspecies primarily nests and forages in dense brush in small wetlands and riparian zones within forested habitats, usually near pooled or running water (Craig and Williams 1998; WAGAP 1997). The subspecies arrives on the breeding grounds in May and June and migrates to southern Mexico and Central America in August (Craig and Williams 1998). Declines in populations are likely due to fragmentation and loss of habitat. Little willow flycatchers forage by hawking larger insects by waiting on exposed forage perches and capturing insects in flight or gleaning insects from leaves (Craig and Williams 1998). Little willow flycatchers have been documented to nest in the North Cascades Complex.

OLIVE-SIDED FLYCATCHER

(FEDERAL SPECIES OF CONCERN)

Olive-sided flycatchers inhabit burned, logged, or openings and edges of coniferous forests, such as water bodies (WAGAP 1997). Individuals perch on tops of coniferous trees or dead tree snags where they forage for large flying insects, and they are also known to nest in conifer trees in the North Cascades Complex. This species migrates to South America in August and returns between May and June. The species is declining throughout the Cascade Mountains where it was historically abundant (SAS 2002). Reasons for decline are unknown, but loss of habitat in wintering territories is suspected (SAS 2002).

CASCADES FROG

(FEDERAL SPECIES OF CONCERN)

The Cascades frog (*Rana cascadae*) is distributed in a relatively narrow band from the Cascade Mountains in northern Washington southward through Oregon to the northern edge of California. Separate populations exist in northern California and near the Washington coast.

The Cascades frog is a “mountain” frog that is generally found between 2,000 feet and 6,200 feet in elevation (Leonard et al. 1993). Populations have declined substantially in northern California and Oregon; however, no published documentation indicates Cascades frog populations are declining in Washington. Bury et al. (2000) reported only a few populations of Cascades frogs in the North Cascades Complex. The likely causes of its decline in California are habitat loss and predation by nonnative fish. Additionally, there is evidence that increased ultraviolet radiation exposure due to the depletion of atmospheric ozone may be another important factor contributing to decreasing numbers.

A survey of lakes and ponds in Olympic National Park found that Cascades frogs were abundant in all habitats, except the deeper lakes where fish were present (Adams et al. 2000) and in lakes containing Northwestern salamanders. The Cascades frog primarily inhabits small pools and streams in subalpine meadows and can also be found in bogs, ponds, small lakes, and marshy areas. They were found to be more common in ponds that had high dissolved organic carbon, which may provide some filtering of harmful ultraviolet radiation (Adams et al. 2000). Cascades frogs are also more common in lakes with emergent vegetation. The distribution of these frogs is irregular, and they are often not found in areas that appear to have suitable habitat (Leonard et al. 1993).

The Cascades frog has been documented in two ponds and one stream location in the Bridge Creek drainage. Cascades frogs have not been recently documented in larger, deeper lakes containing stocked fish, and one explanation for lack of documentation of the species in the North Cascades Complex is that it is the northern edge of the species’ range (Bury and Adams 2000).

COLUMBIA SPOTTED FROG
(FEDERAL SPECIES OF CONCERN, STATE CANDIDATE SPECIES)

The Columbia spotted frog (*Rana luteiventris*) was previously classified as *R. pretiosa*, but recent genetic analysis revealed that specimens classified as *R. pretiosa* were two distinct species geographically isolated from each other (Green et al. 1997). The Oregon spotted frog, *R. pretiosa*, does not occur in the North Cascades Complex (NPS, R. Holmes, pers. comm., 2003).

Populations of the Columbia spotted frog have declined dramatically throughout its range due to loss of wetland habitat and predation by introduced bullfrogs and nonnative fish (Leonard et al. 1993). As a result, it is listed as a federal species of concern and as a candidate for listing in Washington State.

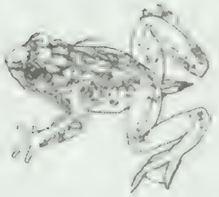
The Columbia spotted frog is a highly aquatic species that lives in mountainous areas in or near cold, slow-moving streams, springs, marshes, ponds, and small lakes with only slight amounts of emergent vegetation (Leonard et al. 1993). In the North Cascades Complex, the Columbia spotted frog has been documented in wet meadows, seasonal streams, seeps, and various lakes and ponds at elevations ranging from 2,500 feet to 5,900 feet (Bury et al. 2000; Liss et al. 1995). Columbia spotted frogs have been documented in several beaver ponds in the Ross Lake basin and in four lakes on the east side of the Cascade Crest. Two of these east-side lakes (Dagger and McAlester) where Columbia spotted frogs have been documented have reproducing populations of stocked fish. These lakes also have extensive meandering inlet and outlet streams that may protect the frogs from predation (NPS, R. Hoffman, pers. comm., 2003).

NORTHERN RED-LEGGED FROG
(FEDERAL SPECIES OF CONCERN)

Of the two subspecies of red-legged frog, the northern red-legged frog (*Rana aurora aurora*) and the California red-legged frog (*R. aurora draytonii*), the northern red-legged frog is the only one found in the Pacific Northwest. The distribution of the subspecies ranges along the west side of the Cascade Crest from southwest British Columbia through most of Oregon and Washington, from sea level to approximately 3,800 feet in elevation, but the frog is more commonly found below 2,000 feet (Leonard et al. 1993).

The northern red-legged frog is a medium-sized frog that is well adapted to the cool, wet climate of the western region of the Pacific Northwest. Adults prefer cool, densely covered riparian areas next to streams, ponds, and lakes. The subspecies have been found up to 350 feet to 1,000 feet from the nearest water source. During warm, dry summers, some red-legged frogs move closer to water sources (Nussbaum et al. 1983). Amphibian surveys in the North Cascades Complex have documented a fairly abundant population of red-legged frog tadpoles and adults in wetlands and ponds in the Ross Lake drainage basin and along the Skagit River near Newhalem. Surveys of the Big Beaver valley in the early 1970s documented five adults near a "willow pond," though the exact location is not known (Taber 1974).

TAILED FROG (FEDERAL SPECIES OF CONCERN)



Tailed frogs are typically found in or near cold, rocky streams.

Tailed frogs inhabit the Pacific Coast and Cascade Range from southwestern British Columbia to northern Oregon. They are typically found in or near cold, rocky streams at elevations from sea level to about 5,500 feet. In the North Cascades Complex, tailed frog tadpoles reach sexual maturity by 6 years. Tadpoles and adults have been documented in the outlets of six lakes in the North Cascades Complex, including Upper Bouck and Nert lakes, which are currently stocked (Bury et al. 2000; Liss et al. 1995). The U.S. Fish and Wildlife Service considers the tailed frog a species of concern because of declining populations.

WESTERN TOAD (FEDERAL SPECIES OF CONCERN, STATE CANDIDATE SPECIES)

Western or boreal toads are quite large and robust with dry, warty skin. Adults and tadpoles secrete a milky white poison when threatened. Western toads are widely distributed from northeast Mexico through the western United States, Canada, and southeastern Alaska. Historically, they were distributed throughout most of Washington State except for the arid portions of the Columbia River basin and plateau. Western toads have been documented from sea level to approximately 6,520 feet near Harts Pass, a few miles east of Ross Lake National Recreation Area. They are most common near marshes and small lakes (Leonard et al. 1993; Mathews 1999).

Intensive surveys of the Big Beaver valley in the early 1970s indicated that Western toads were extremely common in a variety of habitat types except rock slides (Taber 1974). More recent surveys of amphibians in North Cascades Complex lakes found the distribution of adult Western toads to be fragmented, and that they inhabit lower-elevation beaver ponds, floodplain ponds, and gravel-bar pools in the Stehekin, Skagit, and Ross basins. The species is also known to occur in foothill lakes and ponds in the Baker basin, outside the North Cascades Complex. More specific to lakes considered in this plan/EIS, Western toads occur in or near four lakes: Battalion, Lower Thornton, Trapper, and Willow (Liss et al. 1995). Tadpoles were observed at Trapper Lake. These four lakes vary in size from less than 6 acres to 146 acres; from less than 12 feet deep to 160 feet deep; and at elevations ranging from 2,854 feet to 5,343 feet. Unlike the surveys in Big Beaver valley, adult Western toads were typically seen in talus (rock rubble) slopes, as well as near ponds associated with the larger lakes.

The population of Western toads, like many amphibians, appears to be declining throughout the lowlands of western Washington and the high-elevation wetlands of the North Cascades Complex. Some of these declines are difficult to document (particularly in alpine regions) because of a lack of historical records. Because of these declines, the U.S. Fish and Wildlife Service lists them as a species of concern; the WDFW lists them as a candidate species. Western toad tadpoles are probably not preyed upon by fish because they secrete an unpalatable toxin (Corn 1998).

BULL TROUT (FEDERAL THREATENED, STATE CANDIDATE)

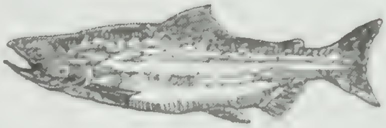
Bull trout (*Salvelinus confluentus*) are a listed species at the federal level and a state candidate species. Dolly Varden (*Salvelinus malma*) are not on the federal or state list, although in 2001 the U.S. Fish and Wildlife Service proposed listing the Dolly Varden as threatened under the "Similarity of Appearance" provisions (66 FR 6: 1628-1632, January 9, 2001). The WDFW refers to bull trout and Dolly Varden char collectively as "native char" because the two species are impossible to reliably distinguish between without genetic analysis. In the study area, Dolly Varden distribution in the Skagit River basin is restricted to Thunder Creek (tributary to Diablo) and tributaries to the upper Skagit River above Ross Lake.

The distribution of bull trout is fairly broad in the west-side drainages of the North Cascades Complex, including Ross Lake, and they were historically documented in the Stehekin River drainage. During extensive surveys, however, none were found (NPS 1999a). It is unclear why bull trout are no longer present in these waters, although the combined effects of over-fishing and successive years of bad weather could be important contributing factors to their disappearance (NPS, S. Zyskowski, pers. comm., 2003). Fluvial (resident in larger streams) and anadromous populations of bull trout currently exist in the Skagit River, while Ross Lake and the Chilliwack River contain lacustrine-adfluvial (lake rearing fish that spawn in streams) populations.

The presence of brook trout in Silver and Hozomeen creeks has generated great concern for potential hybridization (cross breeding) between bull trout and brook trout, although to date, no hybridization has been documented. The current lack of documented hybridization may be related to differences in spawning habitat because brook trout tend to spawn in warmer water, and bull trout spawn in only the coldest water. Though hybridization has not yet been documented, the potential clearly exists (Seattle City Light, E. Conner, pers. comm., 2003).

CHINOOK SALMON (FEDERAL THREATENED)

Chinook (king) salmon are found in the Skagit River and its major tributaries, and smaller numbers are found in the Baker River drainage. Populations of Chinook salmon have been divided into evolutionarily significant units (ESU) for protection under the *Endangered Species Act*. Chinook salmon, currently listed as threatened, is present in the North Cascades Complex, which is part of the Puget Sound ESU. The ecological overlap between Chinook salmon and nonnative trout is questionable, given their vastly different life histories. While hybridization is not known to occur, Chinook salmon fry could be preyed upon or forced to compete with nonnative trout dispersing downstream from mountain lakes. Such competition, however, would take place against the backdrop of the widespread native trout that share similar habitats.



Chinook salmon are found in the Skagit River and its major tributaries.

COHO SALMON (FEDERAL CANDIDATE SPECIES, STATE SENSITIVE SPECIES)

The Georgia Strait / Puget Sound ESU of Coho salmon (*Oncorhynchus kisutch*) is a federal candidate species. Coho are favored by many anglers. Wild stocks of Coho salmon have been greatly reduced throughout California, Oregon, and Washington because of habitat loss, overfishing, hybridization with hatchery stocks, and poor ocean conditions (Behnke 2002). In 1995 these declines prompted the National Marine Fisheries Service to list Coho populations in California and Oregon as threatened. At the same time, however, the National Marine Fisheries Service determined that listing Coho as threatened was not warranted for the Puget Sound / Straight of Georgia ESU, but instead listed that unit as a candidate species.

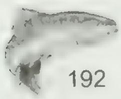
Coho salmon from the Puget Sound / Straight of Georgia ESU are found in most of the major west-side tributaries of the North Cascades Complex, including the Skagit, Baker, and Chilliwack rivers and their higher-order, lower-gradient tributaries. Less abundant than the sockeye, pink, and chum species, Coho salmon spend their first year in the birth tributary and the next 18 months in the ocean before returning to spawn from November through early February. Since the young spend roughly one year in freshwater before smolting (when young salmon swim to the ocean), they must compete with other native salmonids and, potentially, with introduced fish dispersing downstream. Hybridization has only been documented with hatchery strains of Coho and with their close relative, the Chinook salmon, but not with nonnative rainbow, cutthroat, or char.

WESTSLOPE CUTTHROAT TROUT (FEDERAL SPECIES OF CONCERN)

The westslope (inland) cutthroat trout (*Oncorhynchus clarki lewisi*) is currently listed as a species of concern, but because of continued declines, various conservation organizations have recently petitioned the U.S. Fish and Wildlife Service for a rule to list the westslope cutthroat trout as threatened throughout its range (American Wildlands et al. 1998). Two status reviews of westslope cutthroat trout (in September 1999 and August 2003) concluded that the westslope cutthroat trout is not likely to become a threatened or endangered species within the foreseeable future and that listing was not warranted under the *Endangered Species Act* at this time (*Federal Register* 68 (152):46989-47009).

Westslope cutthroat trout inhabit the Stehekin River and its headwater tributaries. They are the only trout native to the drainage that are still present. The westslope cutthroat trout in the Stehekin River drainage are geographically isolated from other populations of westslope cutthroat trout in the western United States (Behnke 2002).

Stocking of rainbow trout in Lake Chelan, and in various lakes at the headwaters of the Stehekin River, has caused hybridization between westslope cutthroat and rainbow trout. Recent genetic research has demonstrated that rainbow trout dispersing downstream from stocked mountain lakes in the Stehekin River drainage are responsible for some of the hybridization. Rainbow trout stocked in



Lake Chelan and various tributaries to the Stehekin River have also hybridized with westslope cutthroats. This ongoing genetic research has found that two genetically "pure" strains of westslope cutthroat are still present in the headwaters of the Stehekin River drainage and in Park Creek. The persistence of these two pure strains may be related to differences in spawning habitat because westslope cutthroats generally spawn in high-gradient waters, while rainbow trout prefer low-gradient streams in the Stehekin River drainage (WFRC, C. Ostberg, pers. comm., 2003).

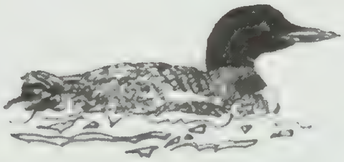
OTHER SPECIAL STATUS SPECIES

ANIMALS

Table 21 lists those species that are recognized as special status species by the state of Washington and are known or likely to occur in the North Cascades Complex but do not have federal status.

TABLE 21: STATE OF WASHINGTON SPECIAL STATUS SPECIES WITH NO FEDERAL STATUS

Common Name	Scientific Name	Species Status
Black-backed woodpecker	*Picoides albolarvatus*	Candidate
Common loon	*Gavia immer*	Sensitive
Golden eagle	*Aquila chrysaetos*	Candidate
Lewis' woodpecker	*Melanerpes lewis*	Candidate
Merlin	*Falco columbarius*	Candidate
Pileated woodpecker	*Dryocopus pileatus*	Candidate
Vaux's swift	*Chaetura vauxi*	Candidate



BLACK-BACKED WOODPECKER (STATE CANDIDATE)

Black-backed woodpeckers inhabit coniferous forests and prefer burned, logged, or swampy areas in the North Cascades Complex. The species nests in tree cavities, usually close to the ground.

Hozomeen Lake is one of only 20 sites throughout Washington State where loon nesting has been confirmed in the last 30 years.

COMMON LOON (STATE SENSITIVE)

Common loons are regular spring and fall migrants and summer post-breeding visitors, with the exception of the pair breeding on Hozomeen Lake. They are rare winter visitors in the North Cascades Complex. Their breeding numbers appear to have declined significantly in Washington State because of the widespread loss of low-elevation lake habitats and associated human disturbance (Richardson et al. 2000). Hozomeen Lake is one of only 20 sites throughout Washington State where loon nesting has been confirmed in the last 30 years. A few loon observations are reported each year from nearly all the major lakes and reservoirs in the North Cascades Complex, but nesting has only been confirmed at Hozomeen Lake where loons have nested

consistently since at least 1971. The area around the lake is closed each season to minimize disturbance. The brook trout food base at Hozomeen Lake, as well as the close proximity to other favorable feeding grounds such as Ross Lake, are probably two key factors in providing favorable habitat. Because of the low numbers of nesting loons in Washington State, common loons are now listed as sensitive in Washington State (Richardson et al. 2000).

GOLDEN EAGLE (STATE CANDIDATE)

Golden eagles are large raptors that occupy mountainous areas. Golden eagles prey mainly on small mammals but also hunt other birds. Although golden eagles may be permanent residents of the North Cascades Complex, there are no known golden eagle nests (NPS, R. Zipp, pers. comm., 2003).

LEWIS' WOODPECKER (STATE CANDIDATE)

In higher elevations, Lewis' woodpeckers nest in open old-growth ponderosa pine with snags but prefer lower-elevation riparian woodlands dominated by cottonwoods. This woodpecker also prefers logged or burned-out areas. They primarily eat acorns, berries, and insects.

MERLIN (STATE CANDIDATE)

Merlins are small, fast falcons that prey on birds and insects. Three subspecies of merlins occur in the North Cascades Complex. The taiga merlin (*Falco columbarius columbarius*) breeds in the high-elevation forests in the North Cascades Complex between April and October (SAS 2002); however, merlins are considered very rare breeders, and the status of nesting in Washington is unknown (WAGAP 2003). Taiga merlins nest in trees near open grasslands, meadows, lakeshores, or forest openings. They may occasionally use the valleys when foraging and during migration (WAGAP 2003).

PILEATED WOODPECKER (STATE CANDIDATE)

Pileated woodpeckers are the largest woodpecker species and is a year-round resident of the North Cascades Complex. Pileated woodpeckers inhabit deep, mature forests and use cottonwood trees (*Populus* spp.) along lakes and riparian corridors to prey on carpenter ants.

VAUX'S SWIFT (STATE CANDIDATE)

Vaux's swift is an insectivore that nests in tree cavities in mature forests. This bird species migrates south in the winter season. Vaux's Swifts are common in suitable habitat throughout the North Cascades Complex (NPS 1999a).

PLANTS

Appendix C, table C-2, lists the plant species that are recognized as special status species by the state of Washington and are likely to occur in the North Cascades Complex, but do not have federal status. There are 26 graminoid (grass) species, 45 forb (a broad-leaved herbaceous plant that is not a grass) species, and 10 fern species that are state listed. It is not possible to establish the presence or absence of any of these species because surveys for plant species of special concern have not been conducted.

In addition to the state of Washington status, plant species of special concern are classified according to their reliance on wetland (riparian) vegetation assemblages. The U.S. Army Corps of Engineers uses this classification system in wetland delineation. The U.S. Fish and Wildlife Service developed the list of plant species of special concern that occur in wetlands.

Wetlands are classified as follows:

> FAC—facultative (occurring in a variety of conditions) species occur 33% to 67% of the time in wetlands; 9 of the state-listed species are facultative species
>
> FACU—facultative upland species occur 1% to 33% of the time in wetlands; 5 of the state-listed species are facultative upland species
>
> FACW—facultative wetland species occur 67% to 99% of the time in wetlands; 12 of the state-listed species are facultative wetland species
>
> OBL—obligate (only occurring in particular environmental conditions) wetland species occur 99% of the time in wetlands; 18 of the state-listed species are obligate wetland species
>
> UPL—obligate upland species are rarely found in wetlands; 37 of the state-listed species are obligate upland species.

VEGETATION

This section describes vegetative communities in the North Cascades Complex. Species that have special status are described under "Plants" in the previous section titled "Special Status Species."

The terrestrial vegetation of the North Cascades Complex is highly diverse as a result of the co-occurrence of climatic gradients and topographic diversity over relatively short distances. Vegetation and wildlife are influenced by several factors, including climatic differences caused, in large part, by two geological barriers in the North Cascades Complex: the Skagit Crest (Boston-Picket-Spickard Divide) and the Pacific Crest. The west sides of these crests have a temperate marine climate, which is characterized by relatively warm winters and cool summers. Precipitation on the west side ranges from 60 to 138 inches per year. East of these crests, the climate is semiarid continental, with colder winters and hot, dry summers. The east side receives between 25 to 130 inches of precipitation per year (Liss et al. 1995; NPS 2003a). The area between the Skagit Crest and Pacific Crest (the Ross Lake drainage) is a transitional zone where vegetation and climatic characteristics are moderated between the mild, wet conditions typical of the west side and the semiarid conditions typical of the east side of the Cascade Crest.

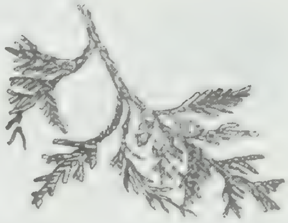
Elevation influences the type, growth, and distribution of vegetation.

Elevation, and the differences in precipitation and temperature related to it, also influence the distribution of vegetation. In this area, precipitation generally increases with elevation while temperature decreases. Four main vegetation zones are recognized based on differences in elevation and dominant vegetation: lowland forest, high forest, subalpine parkland, and alpine. Climatic differences between the east side and west side influence the distribution of these vegetation zones relative to elevation. Vegetation zones on the east side occur at higher average elevations than their west-side counterparts. This means, for example, that while the alpine zone occupies a significant portion of the west-side watersheds, it is restricted on the east side. East-side forests are drier and have less understory vegetation than west-side forests (Liss et al. 1995; NPS 2003a). While these trends are true for most of the North Cascades Complex, local topography also influences the interaction between vegetation zone and elevation. Therefore, most lakes classified in this document as located in a particular vegetation zone vary consistently with elevation, but sometimes, the influence of local topography means this is not always true. For example, in some cases, a lake classified as high forest may occur at a higher elevation than one classified as subalpine.

Discrete subtypes may occur within these broad vegetation zones. The subtypes are described by the dominant plant stature and result in a cover-type classification. Deciduous and/or coniferous trees are dominant in the forest cover type. The shrub cover type is characterized by the predominance of woody shrubs. Meadow cover describes areas where forbs and graminoids are dominant but may include low-lying shrubs as well. Areas that are not vegetated include exposed bedrock, talus slopes, and cliffs. Descriptions of each cover type are described below and are grouped according to climatic region (the west or east side of the Pacific Crest) and vegetation zone. The descriptions are very general and do not necessarily represent the species actually found at individual lakes. Ground surveys at the lakes are essential in order to characterize the riparian vegetation surrounding individual lakes.

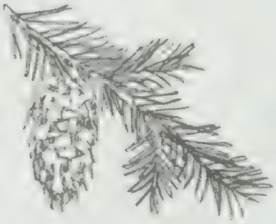
WEST SIDE

The **lowland forest zone** includes 6 of the 91 lakes occurring between 1,350 and 3,380 feet (see "Appendix M: Shoreline Cover Types Around the 91 Study Area Lakes"). Coniferous tree species that dominate the lowland forest cover type are Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western red cedar (*Thuja plicata*). Willows (*Salix* spp.) and vine maple (*Acer circinatum*) are the most common shrub species in this zone. Most lakes in the study area on the west side are surrounded by a combination of the four cover types (forest, shrub, meadow, and bare), although all cover types are not represented at every lake. The forest cover type covers more area in this zone than in higher-elevation zones.



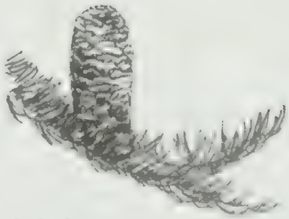
Western Red Cedar

The **high forest zone** includes 10 of the 91 lakes included in this plan/EIS. High forest generally occupies habitat on the west side at elevations ranging between 3,843 and 5,540 feet. The high-forest cover type is dominated by Pacific silver fir (*Abies amabilis*) and mountain hemlock (*Tsuga mertensiana*), with lesser amounts of subalpine fir (*Abies lasiocarpa*), grand fir (*Abies grandis*), and Alaska yellow cedar (*Chamaecyparis nootkatensis*). Douglas fir grows at lower elevations in this zone. Dominant shrub species in this zone are huckleberry (*Vaccinium* spp.) and white rhodedendron (*Rhododendron albiflorum*). As in the lowland forest zone, most lakes are surrounded by a combination of the cover types. The shrub and meadow cover types are more common, and forest cover type is less common than in the lowland forest zone.



Douglas Fir

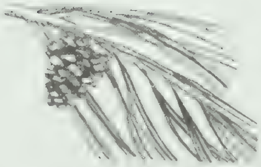
The **subalpine zone** includes 49 of the 91 lakes, and occurs on the west side at elevations between 3,685 and 6,560 feet. It is characterized by a mosaic of tree islands and subalpine meadows. The dominant trees in the tree islands are subalpine fir and mountain hemlock, with lesser amounts of whitebark pine (*Pinus albicaulis*). Forest cover is much less common in the subalpine zone than at lower elevations. At the interface between the subalpine and alpine zones, trees are characterized as Krummholtz, a vegetative growth form characterized by clumped, low-stature trees. Heather (*Phyllodoce* spp., *Cassiope* spp.), huckleberry (*Vaccinium* spp.), and willows are dominant shrubs. The heather-huckleberry community is very sensitive to the effects of trampling and takes longer to recover than other plant communities (Cole and Trull 1992). The meadow vegetation in this zone can be grouped into 11 community types ranging from early successional communities on glacial moraines to heather and huckleberry communities. In general, meadow areas are dominated by sedges (*Carex* spp), rushes (*Juncus* spp.), and hellebore (*Veratrum* spp.). The bare cover type is much more common in the subalpine than in the forest zones.



Subalpine Fir

The **alpine zone** includes 6 of the 91 lakes at elevations ranging between 4,055 and 5,830 feet. Alpine plants are low growing and often mat-forming, and alpine plant communities can be sparse or dense. Alpine cover is characterized by fell fields consisting of sedges, grasses, composites, heather, talus, and snowfields. Meadow cover is less common in the alpine zone than in the subalpine zone. The bare cover type predominates in this zone.

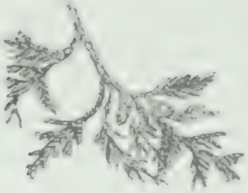
EAST SIDE



Ponderosa Pine

The **lowland forest zone** on the east side includes 1 of the 91 study area lakes that occurs at 2,172 feet. Tree species that dominate the forest cover type are Ponderosa pine (Pinus ponderosa), Douglas fir, and lodgepole pine (*Pinus contorta* var. *latifolia*). Lakeshore vegetation is 29% forest cover. Willows are a common shrub species in this zone. The meadow cover type represents more than half of the riparian vegetation at this lake, and there is no area classified as bare cover type.

The **montane forest zone** on the east slope includes 5 of the 91 study area lakes that occur between 5,375 and 5,630 feet. In addition to the silver fir and mountain hemlock, whitebark pine and larch are also common at higher elevations in this zone. Most lakes are surrounded by a combination of cover types.



Western Larch

The east slope **subalpine zone** includes 14 study area lakes that occur between 4,165 and 6,795 feet. This zone has a more moderate level of precipitation than that of the west slope, and the longer growing season allows subalpine vegetation to extend to the ridgetops in most lake basins. Lakeshore tree islands are dominated by subalpine fir, mountain hemlock, larch (*Larix occidentalis*), and whitebark pine (*Pinus albicaulis*). Larch is more common in higher, colder areas than pine, but they are often found together. Heather, willows, and huckleberry are dominant shrubs. Sedges, grasses, rushes, helleborus, and patridgefoot (*Leutkea* spp.) dominate meadow areas. Again, shrubs, meadow, and bare cover types are more common than the forest cover type.

No east-side lakes are classified as alpine.

DECIDUOUS TREES

Throughout the North Cascades Complex, deciduous trees predominate in moist and exposed areas such as floodplains, riparian areas, and avalanche chutes. Common species include bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera* spp. *trichocarpa*), red alder (*Alnus rubra*), vine maple (*Acer circinatum*), and willow (*Salix* spp.).

RIPARIAN VEGETATION

In an ecosystem context, riparian zones are "the interfaces between terrestrial and aquatic ecosystems. As ecotones, they encompass sharp gradients of environmental factors, ecological processes, and plant communities. Riparian

zones are not easily delineated but are composed of mosaics of landforms, communities, and environments within the larger landscape" (Gregory et al. 1991). The riparian zone of a lake or pond generally consists of the adjacent land that is periodically influenced by flooding, ponding, or soil saturation. The plants and animals that occupy these zones are often uniquely suited to wetland conditions. In the North Cascades Complex, riparian zones can range from very extensive (for lakes surrounded by wet meadows) to minimal (for lakes surrounded by rock and/or glaciers).

Riparian Vegetation: Vegetation found along waterways and shorelines that is adapted to moist growing conditions and occasional flooding.

Most of the lakes in the North Cascades Complex are oligotrophic, meaning they are low in nutrients and very limited in their capacity to produce and sustain aquatic life. Under these conditions, the ecological role of riparian zones is very important because they provide additional sources of nutrients and carbon to the aquatic food chain. The nutrients from riparian zones greatly augment the lakes' sources of carbon and nutrients that are originally derived from phytoplankton and transferred up the food chain.

Lakes commonly receive nutrients from organic debris such as leaves, pine needles, and fallen branches and trees. While some of this material originates within the immediate riparian zone of the lakes, a substantial amount of debris (especially large, coarse woody debris) can be carried over long distances into lakes by flooding and avalanches. As lake elevation decreases, the growing season lengthens, and the density of riparian zone vegetation increases. These conditions increase the overall lake inputs of nutrients and organic debris from the surrounding basin. This general relationship may help to explain why lake productivity in the North Cascades Complex increases with decreasing elevation.

Riparian zone vegetation in the North Cascades Complex varies widely in relation to elevation. Generally speaking, as elevation increases, forest vegetation gives way to lower shrubs and meadows, and the amount of exposed rock (such as cliffs, bedrock, and talus) along the shoreline increases. Many other factors beside elevation influence the composition and structure of riparian vegetation; those factors include soil, surface geology, aspect, and disturbance history (flooding, avalanches). Many of the lakes in the North Cascades Complex (such as Willow Lake) have wide variations in water level and the corresponding extent of riparian zone vegetation, particularly at lower elevations where a longer growing season favors more rapid growth of vegetation.

Trampling of riparian vegetation has been documented around many lakes in the North Cascades Complex. Except for a few instances (such as horse trampling around McAlester Lake), the impacts cannot be assigned to any particular group because lakeshores are used by many different types of backcountry visitors. In the late 1980s, an observational study of angler use around lakeshores in the North Cascades Complex found that, on average, anglers spent three times longer in riparian zones than other user groups. The researchers hypothesized that if time spent in the riparian zone was proportionate to impacts, then anglers could have up to three times as great an impact as hikers (Hospodarsky and Brown 1992). This hypothesis is based on observations that have yet to be tested in a statistically rigorous study. An unknown, though potentially substantial, number of dedicated anglers use rafts when fishing in mountain lakes, and the use of rafts has the potential to greatly reduce the amount of shoreline trampling (WDFW 2001).

The cover type along shorelines can greatly influence where and how anglers travel around lakeshores. Lakeshores that are dominated by bedrock, talus, and/or snow would be less sensitive to trampling than lakeshores with an abundance of low meadow vegetation that allows for easy walking along the shore. The composition of shoreline vegetation around all lakes with a history of fish stocking is provided in "Appendix M: Shoreline Cover Types Around the 91 Study Area Lakes."

CULTURAL RESOURCES

Much of the information presented in this "Cultural Resources" section is from the *Final Resource Management Plan* (NPS 1999a) and *An Updated Summary Statement of the Archeology of the North Cascades National Park Service Complex* (NPS 1998). Appendix J contains additional information on documents and plans related to cultural resources within the North Cascades Complex.

The NPS groups cultural resources by these categories: archeological resources, cultural landscapes, historic structures, museum objects, and ethnographic resources. Each category is addressed in the following section, with the exception of museum objects, which would not be affected by the fishery management actions proposed in this plan/EIS.

ARCHEOLOGICAL RESOURCES

There is evidence that the general North Cascades area was used extensively by Native American groups for at least the last 8,400 years. It is believed that the earliest inhabitants of the area were ancestors of today's Coast Salish and Interior Salish-speaking people such as the Skagit, Chilliwack, Nooksack, Nlakapamux, Chelan, Entiat, and Methow bands. It is likely that numerous other indigenous bands on both sides of the North Cascades Range would have periodically used the resources of the area.

An archeological overview and assessment (NPS 1986) for prehistoric archeological resources predicted the occurrence of hundreds of cultural resources within North Cascades Complex boundaries. Cumulative results of systematic surveys and site evaluations since that time are compiled in the NPS Archeological Sites Inventory Management System (ASMIS) database. As of 1999, less than 5% of the 684,000 acres in the North Cascades Complex had been formally surveyed for cultural resources.

The NPS has recorded 255 prehistoric archeological sites in the North Cascades Complex. Twenty-three of these sites have been determined eligible for the National Register of Historic Places (National Register). Many other sites have been determined ineligible due to loss of site integrity from reservoir inundation (NPS, R. Mierendorf, pers. comm., 2004).

While most sites are located in river valleys, some are also found in alpine and subalpine locales. In general, the resources reflect extensive use of the North Cascades mountain areas for hunting, gathering, and fishing; food processing and cooking; and working with a variety of other local resources. Site types include lithic scatters (chipped and ground stone); features (living floors, hearths, sweat lodges), stone quarries; collecting areas; hunting, gathering, fishing, and food processing camps; rockshelters, overhangs, and caves; rock features including talus pits, rock walls and alignments, and rock cairns; pictographs; culturally modified trees; permanent and semi-permanent villages and camps; and prehistoric trails and resource use areas. The presence of obsidian (jet-black volcanic glass) from sources in California, Oregon, Idaho, and Wyoming clearly suggests that inhabitants of the area utilized broad and sophisticated regional trade networks.

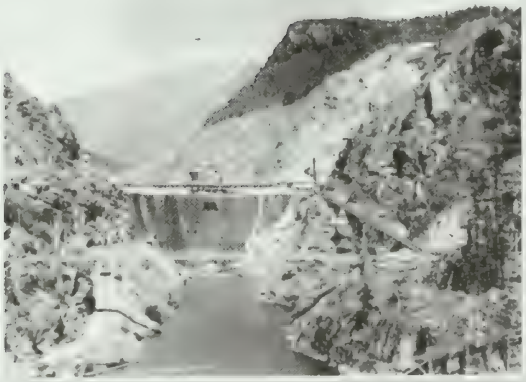
Approximately 89 historic archeological sites associated with 19th and early 20th century settlement and mining have also been identified in the North Cascades Complex. Twenty-nine of these sites have been determined eligible for the National Register (NPS, J. Kennedy, pers. comm., 2004).

For the purposes of evaluating impacts to cultural resources, 6 trails and 8 of the 91 lakes considered in this plan/EIS have been designated sensitive because of an increased potential for impacts to archeological resources from proposed fishery management actions (NPS, R. Mierendorf, pers. comm., 2004). Information regarding these sensitive archeological resources is contained in a confidential document that is not available for public release.

HISTORIC STRUCTURES AND DISTRICTS

Historic development in the North Cascades occurred relatively late, primarily within the last 200 years, partly due to the rugged landscape and relative isolation of the area. Historic contexts identified in a 1986 historic resource study (Luxenberg 1986) include exploration primarily in the Skagit, Cascade, and Stehekin river valleys; followed by settlement, commercial development (including miners), recreation, and administration of the area by the U.S. Forest Service. Forty-three buildings, five sites, and one structure were found to be eligible for inclusion in the National Register as a part of the multiple resource nomination (Luxenberg 1989).

Numerous additional historic resources have been identified in the North Cascades Complex and include cultural landscapes, districts, and structures. These historic resources primarily represent pioneer homesteads; placer, hydraulic, and hard rock mines; wagon roads and trails (for example, mine-to market wagon roads); recreation; and federal land management. Twenty-nine historic structures are listed in the National Register.



Four generators went on-line when Ross Dam was completed in 1952.

The Cascade Pass trail corridor contains several historic roads and trails that likely date back to the late 19th century and form an east-to-west passageway through the North Cascades mountains. One lake has been identified as particularly sensitive to human activity because of several historic sites located in the immediate vicinity (NPS, J. Kennedy, pers. comm., 2004).

Perhaps the most notable evidence of historic human use of the area is reflected in the facilities associated with the Skagit River Hydroelectric Project and associated reservoirs operating in the North Cascades Complex. The 540-foot-high Ross Dam, which created the 11,680-acre Ross Lake, was completed in 1949. Diablo Dam was completed in 1927 and is 389 feet tall; Diablo Lake covers 910 acres. Gorge Dam, completed in 1961, is 300 feet tall and its reservoir (Gorge Lake) inundates 210 acres. Together, the dams, power houses, and related facilities comprise the Skagit River Hydroelectric Project No. 553, an inholding in the North Cascades Complex that is owned and managed by Seattle City Light. Many features of the Skagit River Hydroelectric Project are either eligible for or listed in the National Register, including the company towns of Newhalem and Diablo.

ETHNOGRAPHIC RESOURCES

Ethnographic resources represent tangible evidence of the past and present behavior or knowledge of identifiable human populations in a geographic area. They are often intimately related to other categories of both natural and cultural resources. Such data create an ethnographic baseline for interpreting connections between archeological data and native inhabitants. The ethnographic resource types that have been identified for further study in the North Cascades Complex include historic and contemporary human populations, historic and contemporary subsistence uses and residency, current uses of ceremonial or religious localities by indigenous people, traditional sacred localities and/or objects, ethnogeographic resources, and Traditional Cultural Properties (see National Register Bulletin 38, http://www.cr.nps.gov/publications/bulletins/nrb38/). No ethnographic resources have been documented in the North Cascades Complex, although it is very possible that some do exist (NPS, R. Mierendorf, pers. comm., 2004).

CULTURAL LANDSCAPES

Within the past decade, cultural landscapes have come to formally represent a distinct cultural resource group, reflecting human adaptation to using the natural resources in a given area. Efforts to document and understand the natural and cultural resources of the landscape in the North Cascades Complex were completed in the past, but additional work is believed necessary. The North Cascades Complex contains a diversity of cultural landscape resources including backcountry homesteads, 19th century resort developments, historic administrative areas, and trails. In 1998, as part of a cultural landscapes inventory, 24 individual sites and districts were identified in the North Cascades Complex as cultural landscapes. While most have not been evaluated, several have been determined eligible by the Keeper of the National Register or the Washington State Historic Preservation Office. These cultural landscapes include the International Boundary Corridor, Golden West Lodge, Horseshoe Basin and Black Warrior Mine, Buckner Homestead, and Marblemount Ranger Station.

Sourdough Lookout was constructed in 1932 and is in the National Register of Historic Places.

VISITOR USE AND EXPERIENCE

Visitation to the North Cascades Complex from 1996 to 2002 fluctuated slightly but generally remained at an average of 412,012 people per year (see table 22).

Approximately 449,216 people visited the North Cascades Complex in 2002. The national park portion of the North Cascades Complex received approximately 5% of total visitation, with the highest use in the area around Cascade Pass. The Lake Chelan National Recreation Area experienced 9% of total use, and Ross Lake National Recreation Area experienced 86% of total use. The highest use occurred in July and August and the lowest in January and February. Approximately 80% of the visitors to Ross Lake National Recreation Area (310,700 people) traveled along State Route 20. The wilderness character of the North Cascades Complex accounts to some degree for the relatively low backcountry overnight use. Of the estimated 449,216 visitors in 2002, only 37,231 visitors (this figure includes all backcountry areas including the areas around the reservoirs) spent one or more nights in the backcountry (NPS 2003c).

Visitation increased from 1996 to 1998, then decreased the following two years. Visitation began increasing again in 2001.

TYPES OF RECREATIONAL OPPORTUNITIES IN THE NORTH CASCADES COMPLEX

The majority of visitors (86% in 2002) to the North Cascades Complex recreate in Ross Lake National Recreation Area along State Route 20 and do not venture far from the highway corridor. Recreational opportunities available along the highway corridor include bicycling, day hiking, picnicking, and fishing. Several

TABLE 22: TOTAL VISITATION TO THE NORTH CASCADES COMPLEX, 1996 TO 2002*

	Location				
Year	North Cascades National Park	Ross Lake National Recreation Area	Lake Chelan National Recreation Area	Total (all areas)	Percent Change
1996	27,910	313,565	36,891	378,366	
1997	27,203	332,164	34,300	393,667	4%
1998	32,753	425,209	45,779	503,741	28%
1999	21,488	333,944	50,087	405,519	-19.5%
2000	25,704	273,696	51,825	351,225	-13.4%
2001	27,739	332,061	42,547	402,347	14.6%
2002	20,690	387,936	40,590	449,216	11.6%
Average	26,212	342,654	43,146	412,012	4.2%
North Cascades Complex Average Annual Visitation (1996–2002)				412,012	

Note:

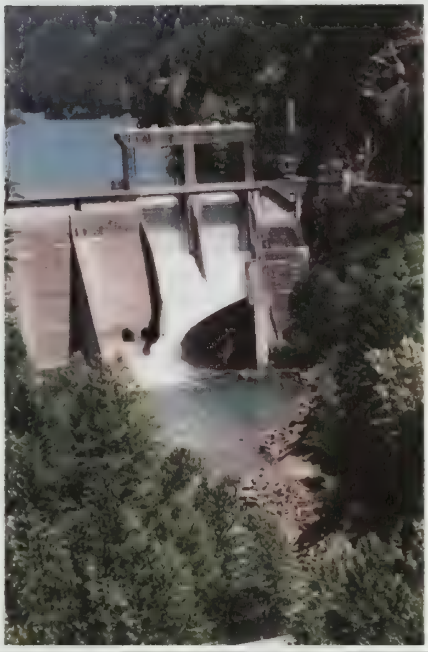
*Visitation information was obtained from http://www2.nature.nps.gov/stats/ (NPS 2003c).

rest stops provide interpretive displays and scenic vistas. Seattle City Light offers tours of the Skagit River Hydroelectric Project, which is popular during the summer months.

Although use is comparatively lower, the backcountry of the North Cascades Complex also offers a wide variety of recreational opportunities, including boating, paddling, hunting (in the recreation areas only), hiking, camping, rock climbing and mountaineering, horseback riding, and sport fishing in mountain lakes, creeks, rivers, and reservoirs. Approximately 8% of visitors in 2002 spent one or more nights in the backcountry.

Boating typically occurs in the reservoirs in the North Cascades Complex. Paddling, such as kayaking or canoeing, occurs on the larger rivers, particularly the Stehekin and Skagit rivers. No boating or paddling occurs in the mountain lakes. Very few people hunt, and hunting is limited to the national recreation areas. Hunting season typically occurs in the fall and winter when mountain lakes ice over and visitation is low.

The following sections describe the recreational opportunities available in the North Cascades Complex.



Since 1918, Seattle City Light has operated the Skagit River Hydroelectric Project to deliver power to the city of Seattle. Gorge Dam (shown above) was completed in 1924.

HIKING AND BACKCOUNTRY CAMPING

Hiking is one of the most popular backcountry activities in the North Cascades Complex, which contains 386 miles of maintained trails that provide a wide range of experiences, including long hikes through deep forested valleys and steep climbs to breathtaking alpine scenery. Lower-elevation trails are usually accessible from early April through mid-October. Higher-elevation trails (which comprise most of the backcountry in the North Cascades Complex) do not open until mid-July and remain accessible through late September.

The backcountry trail network extends beyond the North Cascades Complex boundary onto National Forest System lands and wilderness areas. The Pacific Crest Trail, a designated National Scenic Trail that extends from the California/Mexico border to the Washington/Canada border, passes through the South Unit of North Cascades National Park and Lake Chelan National Recreation Area. This is a popular, well-established trail used by through-hikers and people wanting to access Stehekin Valley from State Route 20. Hikers on the trail tend to congregate in the community of Stehekin for supplies, showers, and mail, but they must take a shuttle van (or hike) from High Bridge to Stehekin. Various other users, such as day hikers and overnight hikers, use portions of the trail without necessarily congregating in any one place, other than perhaps the road/bridge crossing at High Bridge and along State Route 20 outside the park at Rainy Pass.

The 60-mile portion of the Pacific Northwest Trail, which passes through the North Unit of North Cascades National Park and Ross Lake National Recreation Area, is a designated National Recreation Trail. The Pacific Northwest Trail stretches from Glacier National Park in Montana to Cape Alava on the Pacific Ocean in Olympic National Park. The portion of the Pacific Northwest Trail in the North Cascades Complex enters the east side of Ross Lake National

Recreation Area along the Devils Dome Loop, skirts Ross Lake via the East Bank Trail, travels northwest along the Big Beaver Trail into the Little Beaver drainage, and continues west over Whatcom and Hannegan passes. The trail is evolving, and a small section adjacent to State Route 20 in Ross Lake National Recreational Area is currently under construction, so it does not yet completely traverse the park (see "Map 2" located in the envelope that accompanied this plan/EIS).

Camping at Perfect Pass.

Camping is permitted only at designated backcountry campsites or in untrailed cross-country zones. The most commonly used backcountry sites occur along the shores of Ross Lake. These sites accommodate between 25% to 40% of total backcountry overnight users, excluding those who camp in cross-country zones. The North Cascades Complex has over 200 backcountry campsites that are formally maintained by the NPS. The "Map 2 Table" (in the envelope that accompanied this plan/EIS) lists the 91 study area lakes and the cross-country zones and established camps near those lakes.

Cross-country zones are a wilderness area classification used to manage backcountry overnight use in the untrailed portions of wilderness in the North Cascades Complex. There are two types of cross-country zones: Zone I areas include popular climbing routes and bivouac (temporary camp) sites; Zone II areas represent approximately 90% of the wilderness and are considered the most pristine, with little evidence of human presence (NPS 1989). In cross-country zones, dispersed camping is permitted, and camping next to lakes (both with and without fish) is common. The party size in cross-country zones is limited to 12 in Zone I and 6 in Zone II, and campfires are prohibited in all areas of cross-county zones.

CLIMBING AND MOUNTAINEERING

Mountaineering in the North Cascades Complex is becoming more popular.

The North Cascades Complex is a renowned destination for mountaineering. All levels of difficulty are available, from easy ascents to arduous, multi-day approaches and climbs that challenge even the most skilled mountaineer. Anecdotal evidence suggests that some backcountry climbers carry a fishing rod and fish in mountain lakes, although no data is currently available to determine what percentage of climbers fish in this opportunistic fashion. Eldorado Peak is accessed via the Cascade River Road that reaches its highest point near Cascade Pass. Forbidden Peak and Boston Peak are the most popular for mountaineering because they are the easiest to access and a moderate level of difficulty.

In addition to mountaineering, various newer forms of climbing, including bolted sport climbing and bouldering, are becoming increasingly popular in the frontcountry portions of Ross Lake National Recreation Area. The sudden increase in these nontraditional types of climbing has prompted the NPS to place a voluntary moratorium on new route development. An environmental assessment is planned for the winter of 2004 to address the impacts of climbing and to develop a climbing management plan.

STOCK USE AND HORSEBACK RIDING

Many trails and backcountry camps are available for stock use, which is limited to horses, mules, and llamas. Twenty-nine backcountry camps are available for stock use in the entire North Cascades Complex. Horseback riding is especially popular on the eastern side of Lake Chelan National Recreation Area in the Stehekin River valley. Concessioners in Stehekin lead horse tours into the North Cascades Complex, and some of the horse tours include fishing. Of the 91 lakes in the study area, 11 (see table 23) are accessible by horseback (the number of stock [horses, mules, llamas] users that fish in mountain lakes is not known). Seven of the 10 lakes provide good fishing opportunities and 7 are stocked (none are fishless). Six lakes (Coon, Hozomeen, McAlester, Rainbow Upper West and South, and Willow) are stocked by aircraft (refer to table 11 in the "Alternatives" chapter for methods used to transport fry to lakes that are currently stocked). Coon and McAlester lakes are located in the Lake Chelan National Recreation Area near the concessioners.

FISHING

Archeological records indicate that humans have been fishing in the lower-elevation creeks, rivers, and lakes around the North Cascades Mountains for at least 8,000 years; however, the purpose of fishing has changed from subsistence to sport. The locations of sport fishing have also expanded to include historically fishless mountain lakes.

TABLE 23: LAKES ACCESSIBLE BY HORSEBACK

Lake Name	Stocked	Fishing Potential
Coon	Yes	Good
Dagger	No	Good
Dee Dee, Upper	Yes	Good
Hozomeen	No	Good
McAlester	No	Good
Rainbow, Upper (West)	Yes	Poor
Rainbow, Upper (South)	Yes	Poor
Ridley	Yes	Good
Unnamed MR-11-01	Yes	Fair
Willow	Yes	Good

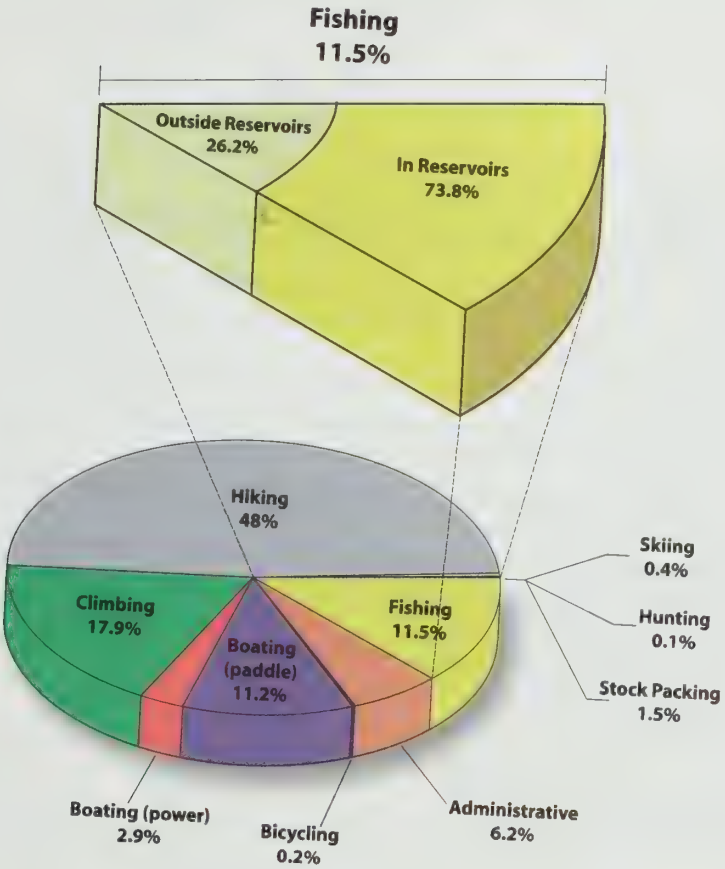
The state of Washington estimates that there are nearly 4,700 high lakes east and west of the Cascades (WDFW 2001). High lakes are defined as greater than 2,500 feet in elevation on the west side of the Cascades, and greater than 3,500 feet on the east side of the Cascades. Of these, 800 are reported to be stocked and 1,000 have reproducing fish populations. Within a 100-mile radius of the North Cascades Complex's boundaries (in Whatcom, Skagit, and northern Snohomish counties), approximately 200 lakes are stocked by the state, and another 200 are estimated to have reproducing fish populations. While the number of anglers using these lakes is unknown, there is opportunity for sport fishing in the vicinity of the North Cascades Complex.

Generations of anglers have fished the mountain lakes in the North Cascades Complex.

Estimates of current angler use were derived from several sources. A survey in 1995 of resident game fish anglers in Washington State found that roughly 175,000 people fished in Washington lakes (WDFW 1996). The mountain lakes in the North Cascades Complex account for roughly 3% of the total number of lakes in Washington, so a general estimate of mountain lake angler use in the North Cascades Complex would be roughly 5,250 people each year. This estimate is likely too high because it does not account for various limiting factors such as access difficulties, distance to large population centers, and differences in use among the various land management agencies that provide mountain lake fishing opportunities outside the North Cascades Complex.

Within the North Cascades Complex, the reservoirs, rivers, streams, ponds, and mountain lakes provide a variety of opportunities to fish in a spectacular mountain setting. Approximately 74% of anglers fish the reservoirs (see figure 9 and table 24), which indicates the reservoirs are the most popular areas to fish. Ross Lake Reservoir is the most popular sport fishing destination on the west side of the park. On the east side of the North Cascades Complex, Lake Chelan and its parent tributary, the Stehekin River, are the most popular fishing locations. Fishing in the natural mountain lakes is largely limited to the summer months when the lakes are ice free, but some of the lower-elevation lakes (such as Willow and Coon) can be fished in the shoulder seasons when the higher-elevation lakes are still ice covered. The running waters of the North Cascades Complex are difficult to fish during spring and early summer because of high flows created by snowmelt.

FIGURE 9: 2003 VISITOR BACKCOUNTY OVERNIGHT USE ACTIVITIES



Note:

The percentages shown in the chart are derived from table 24, which shows the number of nights spent (per person) at permitted backcountry overnight use locations by intended activity during the 2003 summer season.

TABLE 24: RELATIVE POPULARITY OF VARIOUS ACTIVITIES IN THE NORTH CASCADES COMPLEX

Activity	Percent of Total Use[a]	Percent of Total Use Near Mountain Lakes[b]
Administrative use	6.2	11.1
Bicycling	0.2	NA[c]
Boating (paddle)	11.2	2.1
Boating (power)	2.9	NA
Fishing	11.5	10.5
Hiking	48.0	65.1
Hunting	0.1	0.2
Rock climbing and mountaineering	17.9	8.2
Skiing	0.4	0.5
Stock Packing	1.5	1.6

Notes:

a. This "Percent of Total Use" shows the relative percentage or popularity of various activities throughout the North Cascades Complex.

b. The "Percent of Total Use Near Mountain Lakes" column excludes data from the reservoirs and other areas in the North Cascades Complex that do not provide mountain lake fishing. These areas include backcountry camps near the 91 study area lakes and cross-country zones that may contain any of the study area lakes. The data are derived from the backcountry permit database for the summer 2003 field season (NPS 2003c).

c. NA = not applicable.

The North Cascades are a renowned destination for mountaineering.

Backcountry Overnight Use

Data from the 2003 season show that 11.5% of all backcountry overnight users were engaged in fishing (refer to figure 9 and table 24) throughout the North Cascades Complex, not just in the study area lakes. The backcounty permit data account for backcountry overnight use in established camps and cross-country zones of various shapes and sizes. A cross-country zone could have a lake or a group of lakes that may be fishable, but the lake(s) could also be visited by hikers or completely bypassed by climbers headed to a popular peak in the same cross-country zone. Recognizing the limitations of this information, analysis of backcountry data from the 1999–2002 seasons indicates that the average annual backcountry overnight use for all camps and cross-country zones near the 91 study area lakes was approximately 4,035 people per season (see "Map 2" and "Map 2 Table" located in the envelope that accompanied this plan/EIS).

Prior to the 2003 summer season, the backcountry permit data could only provide total estimates of backcountry overnight use by all visitors; no data were available to indicate what fraction of visitors were engaged in sport fishing. To improve the backcountry permit data and enhance understanding of the popularity of various backcountry activities, including sport fishing, beginning in 2003 all backcountry overnight users were asked to identify their primary activity when they were issued a permit to camp. Analysis of those data for the 2003 season (NPS 2003c) indicates that approximately 10.5% of all overnight visitors to camps and cross-country zones near the 91 study area lakes (that is, those areas that provide mountain lake sport fishing opportunities) intended to sport fish (refer to table 24). Using the estimated average annual backcountry overnight use amount of 4,035 people per season (as shown in the previous paragraph), it was estimated that 424 of the backcountry overnight users engaged in sport fishing (4,035 × 10.5% = 424).

Day Use

For most visitors, only a few lakes in North Cascades Complex can be reasonably fished in one day without camping. These eight day-use lakes include Hozomeen, Willow, Ridley, Monogram, Lower and Middle Thornton, Hidden, and Coon (Thunder Lake is also a day-use lake but is currently fishless). It should be noted that a small number of experienced anglers fish in other lakes in the North Cascades Complex without camping overnight.

In the summer of 2003, NPS personnel and researchers from the University of Washington conducted visitor use surveys at the most accessible day-use lakes, except Thunder Lake. The surveys (approved by the Office of Management and Budget—approval number 1024-0224) were conducted on randomly selected weekdays and weekends from July 12, 2003, through August 31, 2003. To conduct the surveys, NPS personnel were stationed at trailheads and surveyed day users as they were leaving the lakes. A total of 444 people were surveyed.

Preliminary analyses from those visitor-use surveys suggest that a very small percentage (less than 3%) of day users surveyed were fishing, excluding Coon Lake, which experiences substantially higher fishing visitation (see table 25). The survey data also indicate that, while day-use fishing is possible at Monogram Lake, no anglers were fishing there, and none were surveyed during the survey period. The 5-mile one-way hike to Monogram Lake is very steep (approximately 5,000 feet of elevation gain), and its arduous access may limit angling to mostly overnight users. The percentage of day users engaged in fishing at Coon Lake was higher (approximately 20%), perhaps because the lake is an easy 15-minute walk from the Stehekin Valley Road and is also relatively close to the community of Stehekin. In summary, the day-use angler surveys indicate that approximately 75 day-use anglers fished during the survey period from July 12, 2003, through August 31, 2003 (see table 25).

TABLE 25: DAY-USE ANGLING STATISTICS

	Hozomeen, Willow, and Ridley Lakes	Lower and Middle Thornton Lakes	Monogram Lake	Coon Lake	Hidden Lake
Estimated total day use is 1,432 people[a]	244	409	113	239	427
Percent of day users engaged in fishing[b]	2.9	2.4	0	20	2.3
Estimated total for day-use anglers is 75	7	10	0	48	10

Notes:

a. Day-use visitors were surveyed on randomly selected weekdays and weekends during the survey period from July 12, 2003, through August 31, 2003. Data from those surveys were extrapolated for the entire survey period to calculate estimates of total day use.

b. The percent of day users engaged in fishing represents the actual percentage of surveyed day users who said they were fishing; those data were also used to estimate the total number of anglers who fished during the survey period.

Angler Use Summary

In summary, deriving an estimate of total angler use of mountain lakes in the North Cascades Complex is very challenging because of the following factors:

> Angler use is small and dispersed across an extremely large area.
>
> An unknown, but potentially significant, number of backcountry overnight users do not acquire backcountry permits.
>
> Many backcountry anglers are seeking a remote wilderness experience and purposefully avoid contact.
>
> There is high variability in arrival and departure times and entry/exit points.

In light of these limitations, the preliminary NPS estimates on sport fishing in the mountain lakes is approximately 499 anglers per year; of that amount, 424 (85%) were backcountry overnight anglers, and 75 (15%) were day-use anglers. These estimates are likely very conservative. A more reasonable estimate of annual angling use of the 91 study area lakes would be about 1,000 people per year, when taking into account incomplete sampling due to dispersed access, highly variable and broad times of entry and departure, and purposeful or inadvertent avoidance of backcountry permit registration.

SOCIAL VALUES

Two predominant issues surround the management of the fishery in the North Cascades Complex mountain lakes. First, the long-held tradition of sport fishing by generations of anglers and their families is predominant among the angler user groups. Second, the conservation of natural processes in the North Cascades Complex is of concern to conservationists and conservation groups, as well as many anglers, especially because the majority of the North Cascades Complex is protected as designated wilderness.

ATTITUDES TOWARD WILDLIFE

Extensive literature exists concerning general social attitudes and values towards wildlife, although no systematic surveys of information specific to the stocking of nonnative fish in the North Cascades Complex exist. For example, Kellert (1976) identified a number of distinct attitudes toward wildlife including aesthetic, dominionistic, ecologistic, humanistic, moralistic, naturalistic, negativistic, scientistic, and utilitarian (see table 26 for definitions).

Most people typically hold more than one attitude toward an issue and react differently in different situations. Nonetheless, it is possible to identify in most people predominant characteristics of a primary attitude toward an issue. For example, ranchers tend to have a utilitarian (value measured in terms of usefulness) attitude towards animals, while scientists tend to take a scientific view (Kellert 1976).

TABLE 26: PEOPLE'S PERCEPTIONS OF ANIMALS IN AMERICAN SOCIETY

Attitude	Key Identifying Terms	Highly Correlated With	Most Antagonistic Toward
Aesthetic	Artistic character and display	Naturalistic	Negativistic
Dominionistic	Mastery, superiority	Utilitarian, negativistic	Moralistic
Ecologistic	Ecosystem, species interdependence	Naturalistic, scientistic	Negativistic
Humanistic	Pets, love for animals	Moralistic	Negativistic
Moralistic	Ethical concern for animal welfare	Humanistic	Utilitarian, dominionistic, scientistic, aesthetic, negativistic
Naturalistic	Wildlife exposure, contact with nature	Ecologistic, humanistic	Negativistic
Negativistic	Avoidance, dislike, indifference, fear	Dominionistic, utilitarian	Moralistic, humanistic, naturalistic
Scientistic	Curiosity, study, knowledge	Ecologistic	None
Utilitarian	Practicality, usefulness	Dominionistic	Moralistic

Source: S. Kellert (1976).

Settlers began stocking North Cascades lakes in the late 1800s with exotic (nonnative) fish (*Oncorhynchus* and *Salvelinus* spp.), and these stocking activities were most likely for subsistence or utilitarian purposes, rather than pure sport. By the 20th century, stocking was a routine management practice for the U.S. Forest Service and various counties to promote sport fishing—a form of recreation.

A shift in values from a purely utilitarian view of the mountain lakes to more scientific and aesthetic views evolved further when in 1933, the Washington Department of Game (currently the Washington Department of Fish and Wildlife) assumed responsibility for stocking mountain lakes throughout the state in order to establish and maintain a recreational fishery. The department's involvement grew largely out of the need to prevent haphazard stocking by individuals without biological expertise. With particular emphasis on systematic assessment of fish species and stocking rates, the department conducted the first lakes fishery research and developed many principles central to fishery management today.

Throughout the 1980s, the NPS and WDFW entered into a series of agreements concerning the management of the fishery (see the "Purpose of and Need for Action" chapter for further information). Attitudes evolved further into more ecological and naturalistic-based values as NPS policies prohibited the introduction of exotic (nonnative) species into areas under its jurisdiction. In order to further define the scientific effects of fish stocking, the NPS initiated a long-term research effort with Oregon State University to evaluate effects of fish stocking on native biota in mountain lakes.

While overall public policy evolved, the concerns of groups representing a variety of attitudes and values also evolved. In 1991 the North Cascades Conservation Council (NCCC) challenged the NPS on a number of issues that brought about a Consent Decree (see appendix A) between the two parties. In part, the Consent Decree ordered the NPS to "conduct a NEPA [*National Environmental Policy Act*] review of the fish stocking of naturally fish-free lakes within [the park] upon completion of ongoing research." This, and the designation of wilderness within the North Cascades Complex, has intensified the debate between the individuals and groups holding various attitudes toward continuation of stocking and conservation of natural processes. These values are further described in the following section.

SOCIAL VALUES OF ANGLERS AND ANGLER USER GROUPS

Sport fishing in the North Cascades Complex follows a tradition that precedes the designation of the North Cascades Complex as a unit of the NPS by almost a century. The traditions and social values surrounding the mountain lake fishery are clearly embodied in two Seattle-based sport clubs: the Washington State Hi-Lakers and Trail Blazers, Inc. The Hi-Lakers are "a diverse group of engineers and schoolteachers, lawyers and contractors, University of Washington professors and research scientists, artists, consultants, and free-lance writers united by a shared passion for mountain lakes" (Bain 2003). Some of the members of the Hi-Lakers are also affiliated with the Trail Blazers. The current membership of the Trail Blazers and Hi-Lakers is approximately 60 people. Membership in these groups appears to be holding steady, with new members joining at the rate of 1 to 5 people a year, offsetting attrition. These numbers, however, are a poor correlation of overall angling use because many anglers do not belong to formal clubs such as these.

Middle Thornton Lake being stocked by a Trail Blazer.

Founded in 1933, the Trail Blazers have voluntarily assisted the WDFW with mountain lakes fishery management, including taking eggs, providing funding for maintenance and equipment, carrying and stocking fry in lakes, and collecting fish observation data. The Trail Blazers have also created and maintained an extensive high [mountain] lake and stream database that includes data on lake and stream identity, location and physical characteristics, fish stocking, fish observations, water chemistry, water biology, and recreational use. In this unique capacity, the Trail Blazers have assumed a role for 70 years as a *de facto* right arm for the WDFW's mountain lakes fishery management program (WDFW 2001).

Although the Trail Blazers and Hi-Lakers represent perhaps the most well-known user groups associated with mountain lakes sport fishing, other mountain lake anglers are also passionate about fishing in mountain lakes but do not belong to a formal group.

The passion for mountain lakes fishing that is shared by the Trail Blazers and Hi-Lakers reflects a set of values and traditions that have been passed down through several generations. Although members of the Trail Blazers and Hi-Lakers enjoy fishing in mountain lakes throughout the state, the rugged, remote, and highly scenic qualities of the mountain lakes in the North Cascades Complex offer an unparalleled backcountry fishing experience that cannot be duplicated elsewhere (Hi-Lakers and Trail Blazers, S. McKean, pers. comm., 2003).

Few studies of the sociological dimensions of sport fishing in North Cascades Complex lakes have been conducted, so an understanding of the social values surrounding sport fishing is limited to secondary data from related studies in similar areas. Results from a study of alpine lake fishing in the Alpine Lakes Wilderness Area in Washington State (Hendee et al. 1977) reveal some useful parallels for understanding the social values surrounding fishing in the North Cascades Range. This study found that sport fishing helped to facilitate natural appreciation and social contact between members of a party and, to a lesser extent, between parties. Indeed, for many anglers the social dimensions of fishing were often more important than successfully catching fish, and this may help to explain why fishermen spent an average of only two hours per day actually fishing. When anglers were asked to rank and prioritize their reasons for visiting lakes, fishing was found to be *secondary* to nature and scenery appreciation, as well as companionship. Other primary motives given for visiting mountain lakes include relaxation, escaping daily routine, hiking, and photography. Taken together, these results suggest that sport fishing is but one of many activities associated with the total outdoor experience.

Some representative opinions expressed during public scoping (conducted in 2003) include:

> Sportsmen, including anglers, were instrumental in getting the . . . park . . . established by Congress in the 1960s . . . it was the intent of the legislation to continue fish stocking in the high lakes of the . . . park
>
> I think that all avenues should be explored in keeping the program running. Catch and release, fly fishing only . . . heartier species, all should be examined to keep what is an outstanding recreational sport going.
>
> . . . to catch a native trout in a pristine lake high up in the mountains with no one else around except a friend, son or daughter and to share this experience with them is one of the greatest highlights of my life.

SOCIAL VALUES OF CONSERVATION GROUPS

In contrast to the value placed upon the mountain lake fishery by groups such as the Trail Blazers and Hi-Lakers, many other groups and individuals believe that the mountain lake fishery in the North Cascades Complex violates the spirit and intent of the *Wilderness Act* and NPS conservation mission. While many anglers are also conservationists, there is a distinction between those who value the stocking of lakes for their enjoyment, in contrast to those who value the conservation and protection of natural processes. Many of the conservation values are intertwined with the value of wilderness. Because the *Wilderness Act* speaks directly to specific wilderness values, that topic is addressed separately.

The establishment of the North Cascades Complex in the late 1960s coincided with the need of the American public to protect natural areas and regulate the protection of air, water, and other environmental resources. During this period,

the NPS also responded to critics who maintained that parks were being managed for their scenic and visitor use values and were not being managed in accordance with ecological principles. Hence, based upon recommendations of the Advisory Board on Wildlife Management in National Parks that were authored by the son of Aldo Leopold, NPS policies shifted to scientific research to understand and promote natural processes (Louter 2003).

In 1975 the North Cascades Complex instituted a new fishery management policy. Up until that time, the NPS allowed stocking, but in 1975 the new policy stated it would no longer stock naturally fish-free lakes but would allow for naturally reproducing populations of fish to exist in lakes that could support this "natural" process. This represented a shift, and compromise, between those holding more ecologically based views and the anglers who had a tradition of sport fishing in the mountain lakes (Louter 2003).

Depending on the park leadership at any one time, a series of policy shifts continued for the next 20 years. These policy shifts resulted in agreements with the state of Washington, as well as a commitment to conduct scientifically based research to help determine the long-term impacts of fish stocking.

The 1991 Consent Decree between the NPS and North Cascades Conservation Council directed the NPS, among other things, to develop a fishery management plan based upon results of scientific study. While the North Cascades Conservation Council is not the only conservation-based group involved in the protection of the North Cascades Complex, it most likely represents the view of others sharing ecologically based values.

During the public scoping period for this plan/EIS, conservationists expressed the following opinion of continued stocking:

> There is no stated objective to establish Park aquatic ecosystems as scientific reference areas and to use them in comparison of other non-park Wilderness area fishery management or other management in aquatic ecosystems of the Cascades. The mere fact that there are literally thousands of Cascade lakes outside of NPS areas should be recognized as part of the analysis. NPS is not constrained to provide fishing opportunities that exist elsewhere.
>
> What are the impacts of planting nonnative fish raised in a controlled environment and with antibiotics into the most pristine environments remaining in the United States?
>
> We are concerned that introducing fish into an environment in which they do not exist naturally . . . leads to impacts to amphibian species and their offspring which become food source for the fish.

The contending social values of preservation and recreation represent in many ways the core of the fishery management controversy in North Cascades (Louter 2003).

WILDERNESS VALUES

The *Wilderness Act*, passed on September 3, 1964, "provides a degree of protection to the resources of the National Park System that the NPS *Organic Act* does not." The House Report accompanying the act, which helps to clarify congressional intent with respect to the act, states that its purpose is to establish a National Wilderness Preservation System made up of designated wilderness areas "because of the undeveloped character of their lands and the need to protect and manage them in order to preserve, as far as possible, the natural conditions that now prevail" (House Report No. 1538, 88th Congress, 2nd session, July 2, 1964).

A basic principle of the *Wilderness Act* is that "uses not incompatible with wilderness preservation should be permitted in areas included within the National Wilderness Preservation System." Another basic principle is that "currently authorized uses that are incompatible with wilderness preservation should be phased out over a reasonable period of time." The House Report contains a "compatible uses" subsection, which states that hunting and fishing are permitted "to the extent not incompatible with wilderness preservation" (House Report No. 1538, 88th Congress, 2nd session, July 2, 1964).

The *Washington Parks Wilderness Act of 1988* designated over 630,000 acres in the North Cascades Complex (North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area) as wilderness. The North Cascades Complex contains close to 400 miles of trails throughout the 93% of the land area that is designated as the Stephen T. Mather Wilderness. The designation of this wilderness did not speak to the appropriateness of fish stocking. NPS policies generally reflect that natural processes should prevail in wilderness areas and recognize that without natural resources, especially native species, a wilderness experience would not be possible. Policies also apply the principle of nondegradation, where natural processes will be allowed as much as possible to support wilderness ecosystems. In addition, NPS policies also direct park managers to eliminate the presence of exotic species where "prudent and feasible" (NPS 2001a). Various elements of the wilderness character of the North Cascades Complex include outstanding opportunities for solitude and the ability to pursue recreational opportunities such as hiking, climbing, and sport fishing in a primitive and unconfined manner. The wilderness characteristics and values of the North Cascades Complex, however, are not completely devoid of human disturbance.

In addition to the formal network of managed trails, there are many informal routes and social trails that are readily visible to the wilderness user. These informal trail networks access a variety of backcountry destinations including mountaineering routes, scenic vistas, and mountain lakes. Many backcountry lakes that contain fish have visible patterns of human use (such as social trails) around readily accessible portions of the riparian zone, including inlet and outlet streams.

Some backcountry users, including anglers, occasionally key in on the patterns of social trails around a lake as a means of determining whether or not a lake contains fish. Those who are opposed to the mountain lake fishery often point to

the social trails around lakes that contain fish as evidence that the mountain lake fishery contributes to a derogation of wilderness aesthetics. This is because trails around lakes detract from a sense of solitude and provide evidence of human manipulation (for example, stocking) of natural processes. Those who favor the mountain lake fishery point out that other users besides anglers are also responsible for social trails around lakes. They argue that stock (horses, mules, llamas) users, in particular, are responsible for some of the most egregious examples of trails and riparian zone impacts.

Some representative opinions expressed during the public scoping period are presented below.

> Assess the lakes as scientific reference areas for other management agencies in other parts of the Cascades. Discuss role of NPS policies in light of the broader Cascades ecosystem. As directed by Congress the Park is to be kept in Wilderness and pristine condition and the surrounding National Forests are managed for multiple uses.
>
> Let the wilderness be wild, let the high alpine lakes or all the lakes in the wilderness live and evolve on their own without human fish stocking.
>
> Acknowledgement of a wilderness overlay was completely ignored in the presentation I attended . . . what are the effects on wilderness from present stocking?

Visible signs of human disturbance aside, the interpretation of the *Wilderness Act* as legislation protecting natural processes versus protecting an esthetic experience is currently the subject of litigation and court debate.

HUMAN HEALTH

HUMAN HEALTH CONCERNS WITH POTENTIAL CONSUMPTION OF CHEMICALLY TREATED FISH

This plan/EIS considers the use of antimycin for chemical treatment. Antimycin is registered as Fintrol® with the U.S. Environmental Protection Agency (EPA) for use by state and federal fish and wildlife agencies in fish management projects. According to the PICOL database maintained by Washington State University, Fintrol Concentrate - Antimycin A (EPA No. 39096-2) is presently registered for use as a fish toxicant in Washington (WDFW 2004). As described in the "Alternatives" chapter of this plan/EIS, antimycin works by entering the fish gills and irreversibly blocking cellular respiration (Rosenlund and Stevens 1992). Antimycin, when used in proper concentration, is less harmful to nontarget aquatic animals than the recommended concentration of rotenone, the only other piscicide that is registered with the EPA for general use in the United States (Finlayson et al. 2002; NPS 2000b). Antimycin is also considered to be harmless to waterfowl, mammals, and humans at concentrations needed to control fish, and following application, it degrades rapidly (Rosenlund and Stevens 1992). Antimycin is the only control method, other than dewatering, that is capable of complete eradication of fish populations (WDFW 2004). It also controls all post-embryonic life stages and can be selective by fish species (Finlayson et al. 2002). For all of these reasons, antimycin would be the preferred toxicant for fish removal.

Concern has been expressed about the potential effects on human health from consumption of treated fish. An undated Fintrol® Concentrate label from Aquabiotics Corporation (see appendix L) recommends that "pending the conclusion of studies now in progress, fish killed with antimycin A should not be consumed by man or animals." Although specific effects are unknown, antimycin reportedly has little impact on nontarget species such as humans. Antimycin is toxic to target species at extremely low concentrations, so only very small amounts of the chemical are needed to kill fish. The concentration of antimycin necessary to remove fish is considered to be harmless to humans, and antimycin breaks down very quickly in a fish's body, reducing the likelihood of contamination if fish are caught and consumed (NPS, R. Zipp, pers. comm., 2003; Rosenlund and Stevens 1992).

The potential for human consumption of fish treated with antimycin is low or non-existent due to the closing of lakes to be treated, educational materials posted, the extremely low dose used for treatment, and treatment of discharged waters. These mitigation measures are further described in appendix I, and the analysis of impacts is described in the "Human Health" section in the "Environmental Consequences" chapter.

HUMAN HEALTH CONCERNS WITH POTENTIAL EXPOSURE TO METHYL-MERCURY AND PERSISTENT ORGANIC POLLUTANTS THROUGH CONSUMPTION OF EXPOSED FISH

There is a small but growing body of evidence indicating that the water quality of lakes in the North Cascades Complex is being tainted by persistent organic pollutants (such as polychlorinated biphenyl [PCB], dichlorodiphenyltrichloroethane [DDT], toxaphene, and methyl-mercury). These anthropogenic compounds enter the atmosphere as volatile contaminants and can be transported for long distances. The compounds can be deposited through condensation and precipitation. The highest amounts of contaminated snowfall are often deposited at high elevations in glaciers and snowfields. Meltwater washes these pollutants into mountain lakes and streams, where they can become absorbed and accumulated in the food chain. This process has been well documented in the Canadian Rockies where researchers there found that contaminant levels in fish tissues are well above the residue guidelines for piscivorous wildlife such as otters, bald eagles, and ospreys (Blais et al. 1998).

Out of concern that bioaccumulation of persistent organic pollutants and methyl-mercury might be occurring in the mountainous national parks in Washington, in the summers of 2002 and 2003, researchers with the U.S. Geological Survey - Water Resources Division collected and analyzed fish tissues from select high-elevation lakes in the North Cascades Complex, including Upper Wilcox, Skymo, Green, and Copper lakes. Fish tissue samples from Green Lake were found to contain concentrations of methyl-mercury and organochlorine contaminants that approached the threshold for human consumption. Twenty-eight different organochlorine compounds were analyzed for, and only two were observed: total PCBs and DDE (dichlorodiphenyldichloroethylene). Both of these compounds were detected at concentrations below the Food and Drug Administration Action Levels for fish tissue of 2 and 5 milligrams per kilogram (mg/kg), respectively. The 5 mg/kg Action Level is for total DDT, which includes DDE (EPA 2004). However, the average PCB concentrations in fish from all sampled North Cascades Complex lakes exceeded EPA's screening value (0.02 mg/kg for recreational anglers) for elevated cancer risk (EPA 2004). Methyl-mercury concentrations were likewise below EPA criteria; however, in at least one lake, concentrations were approaching the methyl-mercury tissue screening values of 0.31–0.47 mg/kg (EPA 2004). Exceedance of these recommended values suggests that long-term consumption of fish (two 8-ounce meals per month every year over a 70-year lifetime) from such places may increase the likelihood of developing cancer or chronic systemic effects. The researchers caution that these fish tissue results are preliminary, and additional sampling is needed. Nonetheless, the results indicate that contaminant levels in Green Lake in the North Cascades Complex are similar to levels found in Green Lake in Seattle (P. Moran, pers. comm., 2004).

DDE is an environmentally persistent metabolite (or residue) of DDT.

SOCIOECONOMIC RESOURCES

The North Cascades Complex is less than a four-hour drive from six major metropolitan and economic centers: Bellingham, Everett, Seattle, Tacoma, Spokane, Washington; and Vancouver, British Columbia. The North Cascades Complex is located in the eastern portion of Whatcom County and extends into eastern Skagit County and northern Chelan County. The unincorporated communities of Diablo and Newhalem in Whatcom County are located along State Route 20, which runs east-west through the Ross Lake National Recreation Area and portions of Whatcom and Skagit counties. The Lake Chelan National Recreation Area is located at the south end of the North Cascades Complex, entirely within Chelan County and bordering Okanogan County on the east. The unincorporated community of Stehekin is in the Lake Chelan National Recreation Area (see “Map 1” or “Map 2” located in the envelope that accompanied this document).

Most urban development in Whatcom and Skagit counties is located at the western end of the counties. Areas adjacent to the North Cascades Complex are primarily rural. The towns and cities that travelers pass through on the way to the North Cascades Complex include Burlington, Sedro-Woolley, and Hamilton. The unincorporated communities of Rockport and Marblemount are located along State Route 20, which connects to Interstate 5 (I-5) in Burlington. Most visitors from the Puget Sound area would travel north on I-5 and east on State Route 20 to reach the North Cascades Complex. Highway 530 extends east from I-5 at Arlington and travels through Oso, Hazel, and Darrington before joining State Route 20 at Rockport to the north. Arlington lies 4 miles east of I-5 at Highway 9 and Highway 530. Towns along State Route 20 east of the North Cascades Complex include Mazama, Winthrop, Twisp, Carlton, and Methow. State Route 20 is closed in the winter. The Lake Chelan National Recreation Area and the community of Stehekin are accessible by trail, small plane, boat, and passenger-only ferry.

In rural areas with natural resources (for example, timber resources), small communities are at times built around certain industries (such as logging or agriculture-related manufacturing) dependent on the available natural resources of the area. As long as the industry endures, the community survives and may grow; however, if an industry on which a community is highly dependent suffers, the community’s economy likely suffers as well. In natural resource-dependent areas along the west coast of the United States, communities have had to diversify their economies due to decreases in timber production. Local economies have grown in the tourism, service, and trade sectors. This phenomenon has also occurred in communities surrounding the North Cascades Complex.

Many small communities were built around natural resource-based industries such as logging.

Tourists to North Cascades Complex contribute to the economy by spending money at local and regional businesses on lodging, gasoline, food, permits and fees, and souvenirs. These expenditures create jobs and income that, in turn, create secondary economic impacts. Businesses patronized by tourists are typically in the services and retail trade industry categories. In the counties of Whatcom, Skagit, and Chelan, trade and services together account for 53% of employment (WESD 2003).

Some specifics about the economies of the three counties in which the North Cascades Complex is located are provided in the following sections.

WHATCOM COUNTY

GENERAL BACKGROUND, LAND USE, AND POPULATION

Whatcom County is bounded by the Canadian border to the north, Okanogan County to the east, Skagit County to the south, and the Strait of Georgia and Bellingham Bay to the west. The North Cascades Complex encompasses the eastern portion of the county. The city of Bellingham's population is 57,830—the highest of all cities in the county. Population growth has been driven primarily by in-migration (Whatcom County 1998). Bellingham is located in the western third of the county along with the other more-populated areas of the county.

During the period 1980 to 1990, Whatcom County's population grew less than 2% per year on average. During the next decade (1990 to 2000), the average growth rate increased to approximately 3% per year. In 2002, approximately 174,500 people lived in Whatcom County, reflecting an approximate 1% growth rate from the previous year. The Washington State Office of Financial Management projects that the county's population could be approximately 189,100 by the year 2012; Whatcom County projects a 2015 county population of 220,366 people (Whatcom County 1998; OFM 2002). Whatcom County's population represents approximately 3% of the Washington State population. As a whole, the county grew faster than the state between 2000 and 2001 and also during the period 1990 to 2000.

County population demographics and in-migration affect land use patterns. Areas influenced by seasonal residency include Point Roberts, Birch Bay, and the Paradise Lakes / Peaceful Valley area near Kendall. Many seasonal homeowners are permanent residents of Canada. In addition to vacation homes shaping the culture and demography, older populations are increasing in size in Whatcom County relatively faster than in the state of Washington as a whole, especially the 50 to 69 and over-75 age groups (Whatcom County 1998).

Future land use patterns in Whatcom County would likely be influenced by existing future development patterns, existing transportation systems, local and international economics, and environmental and natural resource land constraints. Agriculture and forestland would likely continue to dominate the landscape (Whatcom County 1998). Whatcom County has a major university; access to markets in British Columbia, Puget Sound, California, Alaska, and Asia; and an existing transportation infrastructure (including seaport facilities, rail, air, and highway) (Whatcom County 1998).

As shown in table 27, income and the value of housing in Whatcom County are slightly lower compared to Washington State as a whole.

ECONOMY AND INDUSTRY TRENDS

Whatcom County's economy was traditionally based in agriculture, fishing, forestry, and mining. Throughout the 1950s, these four industries represented more than 25% of the county's total employment. Since the 1960s, increased manufacturing, trade, services, and government economic activities have diversified the county's natural resource base.

Whatcom County also gained highway access in the early 1970s. Interstate 5 provided freeway access to Whatcom County urban areas from British Columbia, Canada, and the central Puget Sound region. Western Washington University's enrollment has increased, making the university one of the county's major employers.

Currently, Whatcom County's economy is centered on agriculture/food processing, fishing/fish processing, timber/wood processing, manufacturing, retail trade, and tourism. Resource-based industries in recent years have come to account for just under 6% of county employment (Whatcom County 1998).

Beginning in 1989, Canadian investment in Whatcom County manufacturing grew. British Columbia manufacturers developed operations there to take advantage of lower operating costs and access to U.S. markets. Canadian influences contribute substantially to the county's economy (Whatcom County 1998); for example, the Canadian manufacturing investment has been estimated at over $86 million, creating over 1,300 direct jobs.

The large Canadian consumer population in Whatcom County, among other effects, has created a relatively large retail sector. In 1994, estimates indicated that over 25% of county employment was related to Canadian consumer activity, and 30% to 40% of county retail activity depended on the Canadian shopper (Whatcom County 1998).

TABLE 27: WHATCOM COUNTY DEMOGRAPHICS

Measure	Whatcom County	Washington State
Population, 2001 estimate	170,849	5,987,973
Population percent change, April 1, 2000–July 1, 2001	2.4%	1.6%
Population, 2000	166,814	5,894,121
Population percent change, 1990–2000	30.5%	21.1%
Persons 65+ percent change, 2000	11.6%	11.2%
Housing units, 2000	73,893	2,451,075
Median value of owner-occupied housing units, 2000	$155,700	$168,300
Median household money income, 1999	$40,005	$45,776
Per capita money income, 1999	$20,025	$22,973

Source: Census 2003.

TOURISM

Whatcom County tourism has developed into a $70 million industry, employing approximately 2,500 people. The county's natural scenic attractions draw 6 million to 7 million visitors a year (Whatcom County 1998). The county's resort areas include Birch Bay, Point Roberts, the Mount Baker winter recreational area, and Semiahmoo Spit.

LOCAL BUSINESSES

A variety of businesses provide recreational services and supplies in the vicinity of the park. Some include sporting goods stores, angling stores, and small convenience stores.

SKAGIT COUNTY

GENERAL BACKGROUND, LAND USE, AND POPULATION

Skagit County is located between the cities of Vancouver, British Columbia, and Seattle, and connects the San Juan Islands and North Cascades via State Route 20. Skagit County's *2000 Comprehensive Plan* (Skagit County 2000) focuses on current and proposed land use. The county uses four land use designations to apply regulations and standards: (1) Natural Resource Lands, (2) Urban Growth Areas, (3) Rural Areas, and (4) Open Space. National park and recreation lands, along with wilderness, were designated as Open Space. The county is comprised of 130,853 acres of national park and recreation land and 83,539 acres of wilderness (Skagit County 2000).

Skagit County's population, which represents less than 2% of Washington State's population, grew slightly faster than the state's population during the period 2000 to 2001, similar to Whatcom County's population growth. The county population also grew faster than the state during the period 1990 to 2000. Skagit County has more residents over the age of 65 when compared to the state as a whole, and has a lower income and lower median value of housing units when compared to Washington State (table 28).

TABLE 28: SKAGIT COUNTY DEMOGRAPHICS

Measure	Skagit County	Washington State
Population, 2001 estimate	105,247	5,987,973
Population percent change, April 1, 2000 – July 1, 2001	2.2%	1.6%
Population, 2000	102,979	5,894,121
Population percent change, 1990–2000	29.5%	21.1%
Persons 65+ percent change, 2000	14.6%	11.2%
Housing units, 2000	42,681	2,451,075
Median value of owner-occupied housing units, 2000	$158,100	$168,300
Median household money income, 1999	$42,381	$45,776
Per capita money income, 1999	$21,256	$22,973

Source: Census 2003.

ECONOMY AND INDUSTRY TRENDS

The Upper Skagit Indian Tribe owns and plans to develop a substantial amount of property at the Bow Hill Road / I-5 interchange. The Tribe's existing casino at Bow Hill Road already generates 550 jobs, with an annual payroll of $12 million. Tribal members hold over 70 of the 550 jobs. The Tribe is planning additional commercial and economic development that will tie into the Tribe's culture, history, and relationship with the land (Skagit County 2000). The Bow Hill Road / I-5 interchange is approximately 70 miles from the west entrance of the North Cascades Complex.

One of the county's objectives is to provide for small-scale recreational and tourism uses that could help to diversify the economy of rural Skagit County. In the eastern portions of the county, many of the existing towns and rural residential areas have experienced a downturn in economic activity related to natural resources, similar to what has occurred in Whatcom County. In the North Cascades Complex and along the scenic North Cascades Highway (State Route 20), the eastern portions of the county have begun to experience an evolution from a primarily natural resource-based local economy to one that also includes services to tourists.

TOURISM

During the summer months, approximately 300,000 visitors travel through eastern Skagit County. During the winter, State Route 20 closes, tourist travel drops substantially, and local economic activity decreases (Skagit County 2000).

LOCAL BUSINESSES

A variety of businesses provide recreational services and supplies in the vicinity of the park. Some include sporting goods stores, angling stores, and small convenience stores.

CHELAN COUNTY

GENERAL BACKGROUND, LAND USE, AND POPULATION

Chelan County is bordered on the north by Skagit, Okanogan, and Snohomish counties. On the east, Douglas County borders Chelan County, and its southern neighbor is Kittitas County. To the west, King County borders Chelan County. Chelan County is one of the largest counties in the state of Washington. Approximately 90% of the county is public land, including Lake Chelan National Recreation Area, Wenatchee National Forest, Glacier Peak Wilderness Area, Chelan Butte Wildlife Refuge, and parts of North Cascades National Park. The Columbia River and the Entiat River also run through Chelan County. The Columbia River is a water source for drinking and irrigation.

Chelan County comprises 2,921 square miles and seven growth areas, including Mission Urban, Chelan Urban, Entiat Urban, Greater Wenatchee Area Urban, Cashmere Urban, Leavenworth Urban, and Rural and Resource Lands.

Chelan County is also one of the fastest growing counties in Washington State. As of 2000, Chelan County had a total population of 62,200 people. Between 1980 to 1990, the population grew 16%, and between 1990 and 2000, the population grew 27%. Fifty-five percent of the population growth occurred in the cities. The enrollment in the three school districts in Chelan County increased by 19% to 25% (Chelan County 2000).

The medium household income in 1999 was $37,316 (table 29), and approximately 12% of residents lived below the poverty level.

ECONOMY AND INDUSTRY TRENDS

The county's unemployment rate was approximately 9% in the year 2000. Most jobs in the county are in government, educational services, or retail trade. In 2000, employment in the manufacturing sector was 8% of the county's total employment (Chelan County 2003). Although agricultural production is also a large economic presence in Chelan County, the county is comprised of 90% public lands.

LOCAL BUSINESSES

A variety of businesses provide recreational services and supplies in the vicinity of the park. Some include sporting goods stores, angling stores, and small convenience stores.

TABLE 29: CHELAN COUNTY DEMOGRAPHICS

Measure	Chelan County	Washington State
Population, 2001 estimate	67,133	5,987,973
Population percent change, April 1, 2000–July 1, 2001	0.8%	1.6%
Population, 2000	66,616	5,894,121
Population percent change, 1990–2000	27.5%	21.1%
Persons 65+ percent change, 2000	13.9%	11.2%
Housing units, 2000	30,407	2,451,075
Median value of owner-occupied housing units, 2000	$148,400	$168,300
Median household money income, 1999	$37,316	$45,776
Per capita money income, 1999	$19,273	$22,973

Source: Census 2003.

CURRENT ESTIMATED SPORT FISHING EXPENDITURES TO THE REGIONAL ECONOMY

The estimated number of visitors to North Cascades Complex in the 2003 season who engaged in mountain lake sport fishing is estimated to be approximately 1,000. This estimate is from one year of surveying visitors (NPS 2003c) who applied for a backcountry permit. The number is consistent with the park's observations for the 2003 season that those who engage in sport fishing represent 10.5% of backcountry permits that were issued to users going to camps or zones near the 91 lakes in the study area. It is also consistent with the 1992 Visitor Services Project that estimated 12% of Lake Chelan National Recreation Area visitors engaged in sport fishing (NPS 1992). Day use of the study area lakes appears minimal compared to overnight use; therefore, day-use expenditures are most likely also a small part of overall angler expenditures (see the section titled "Visitor Use and Experience" in this chapter). The WDFW estimates that approximately $49.79 per trip is expended by those who sport fish in the state (WDFW 1996).

Using this estimate of expenditures, and the angler use of the study area, the total annual direct expenditures of anglers to the North Cascades Complex is approximately $50,000. If assuming that 20% of all backcountry overnight users engaged in sport fishing, the annual direct expenditures would be slightly higher.

IMPLAN is a software program with region-specific input/output data sets that is used to estimate economic impacts from projects. A study area (including Whatcom, Skagit, and Chelan counties) was modeled in IMPLAN, and regional input/output data for each industry was calculated to get an estimate of current economic contributions of those who use the study area for sport fishing. Since sport fishing is not a standard IMPLAN sector, the model used a combination of economic sectors: agricultural, forestry, and fishery services; sporting and athletic goods; food stores; eating and drinking establishments; and hotels and lodging places. Multipliers for employment, output, and labor income were then estimated for the sport-fishing industry. When factoring in the relationship between output, jobs, and income from sport fishing associated with the North Cascades Complex mountain lakes fishery, the direct economic output ($50,000 annually) within the three-county area would most likely support one to two associated direct jobs and $10,000 in direct labor income on an annual basis (IMPLAN, Copyright Minnesota IMPLAN Group, Inc.).

The total (direct plus secondary) spending that can be attributed to sport fishing in the North Cascades Complex represents, at most, 0.001% of total retail sales in the three-county area, and 0.006% of total retail sales in the combined unincorporated areas of the three counties (WDOR 2003). This means that revenues from mountain lakes angling account for roughly $1 out of every $100,000 spent in the three-country region. In comparison to the three-county economy as a whole, these expenditures are not substantial.

CURRENT ESTIMATED SPORT FISHING EXPENDITURES TO THE LOCAL ECONOMY

There are no fishing guide services in the North Cascades Complex; however, private local outfitters take visitors on trips to backcountry lakes in the North Cascades Complex in part, and at times, to fish. Typically, other recreational activities are also offered on these trips. While there is very little local data on angler expenditures, business owners have provided some information on the relative importance of sport fishing. Interviews with proprietors of local businesses on the west side of the North Cascades Complex that cater to anglers indicate that mountain lakes fishing in the North Cascades Complex is very limited and accounts for a negligible portion of revenues. A variety of factors appear to contribute to the limited use, including access difficulties, perception of fishing as being prohibited, and a general lack of knowledge that many mountain lakes in the North Cascades Complex contain fish.

A very different perspective of the socioeconomic importance of backcountry lakes was provided by the proprietor of the Stehekin Valley Ranch in Lake Chelan National Recreation Area. When asked how their business would be affected if sport fishing opportunities were reduced or eliminated, they said they would lose visitors because fishing provides an important incentive for visitation. Fishing mountain lakes is very important for their pack trips and day trips. They estimate that 28 guests per day visit their ranch from June through August. Regarding pack trips, the Rainbow Lake fishery is very important. Day trips to Coon Lake are also an important part of their business, especially during the spring and fall seasons when the high country cannot be reached. Stehekin Valley Ranch believes that 90% of their guests visit Coon Lake because the lake is an easy hike, and it is only 1 mile from the road and 3 miles via horseback from the Stehekin Valley Ranch. The ranch estimates that 25% of its guests fish Coon Lake in the spring, and 25% of the guests fish the Stehekin River in the summer. In the fall, 40% of the guests fish, mostly in the Stehekin River, but many again turn to Coon Lake. Overall, they believe that stocking should continue everywhere that it is economically feasible (Stehekin Valley Ranch, C. Courtney, pers. comm., 2003).

Coon Lake is a popular fishing destination in the Stehekin Valley.

The 1995 *Lake Chelan General Management Plan* offers yet a different perspective of the reasons people visit the Stehekin area. The *General Management Plan*, using data from 1992, identifies sightseeing, hiking, wildlife observation, photography, and bicycling as the primary visitor activities for people visiting Stehekin. The 10%–12% of visitors who do visit the area and engage in sport fishing is a relatively small proportion of the annual visitation to the area (NPS 1995).

NORTH CASCADES COMPLEX MANAGEMENT AND OPERATIONS

RESOURCES MANAGEMENT

Resource management in the North Cascades Complex is a critical component of overall park operations. NPS staff in the Resource Management Division focus on two broad categories of management actions: science and stewardship. Scientific pursuits include inventorying and monitoring park resources and conditions as they change through time due to various natural and human influences. Stewardship in the North Cascades Complex primarily involves minimizing and mitigating the impacts of human actions on natural and cultural resources. The emphasis on stewardship is preservation and maintenance of natural processes, as opposed to specific features.

The WDFW plays a central role in managing fish and wildlife populations in the North Cascades Complex, particularly in the recreation areas where hunting and cooperative management of game are authorized as part of its enabling legislation. Regarding fishery management, the NPS defers to WDFW regulations for setting creel limits and for management (including stocking) of game fish in the reservoirs, running waters, and mountain lakes.

In recent years, resource management activities in the North Cascades Complex have focused heavily on improving the baseline knowledge of both natural and cultural resources, as part of a national effort by the NPS to inventory and monitor park resources as part of its Natural Resource Challenge initiative. The initiative is an effort to improve management decisions by enhancing knowledge and understanding of NPS resources. In support of this effort, Congress is providing funding to the NPS for inventorying, monitoring, restoration, research, and education. The North Cascades Complex aquatics program has been focusing on

- monitoring salmon in the Skagit River and its tributaries
- monitoring benthic macroinvertebrate streams and lakes throughout the North Cascades Complex
- systematically inventorying the distribution and abundance of amphibians in terrestrial and aquatic habitats to improve knowledge of amphibian distributions
- inventorying stream resident fish populations and stream habitats
- developing long-term stream and lake monitoring protocols

EDUCATION AND INTERPRETATION

The goal of the Interpretation Program in the North Cascades Complex is to provide for public enjoyment and promote understanding, awareness, and appreciation of the natural, cultural, scenic, and scientific values of the North Cascades Complex and the surrounding ecosystem. Education and interpretation are also used as tools to solicit visitor participation in reducing resource impacts. In addition, the resources of the North Cascades Complex are used as an educational base for a wide variety of age groups.

The National Park Service maintains visitor centers in Newhalem (shown in photo), Sedro-Woolley, and Marblemount.

The Interpretation Program staff maintain a state-of-the-art visitor center in Newhalem, a Wilderness Office in Marblemount, and a visitor center in Stehekin at the historic Golden West Lodge. Visitor information is also provided at the NPS headquarters office in Sedro-Woolley and at the U.S. Forest Service Station in Glacier. Interpretive programs are provided throughout the developed areas in the North Cascades Complex.

Educational materials include bulletin boards, wayside exhibits, interpretive displays, and various trail guides and handouts for visitors. A few of these guides discuss sport fishing as part of a suite of recreational opportunities available to visitors. The guides also educate park visitors about the mountain lake fishery in an attempt to promote an awareness of the ecological issues and concerns that are being addressed at length in this plan/EIS.

MAINTENANCE

The Maintenance Division in the North Cascades Complex performs many visitor use and development services related to boating, camping, hiking, sightseeing, education, and interpretation. The division maintains buildings, utilities, roads, and the extensive backcountry trail and camp network.

CONCESSIONS

Commercial uses in North Cascades Complex include concessions and Commercial Use Authorization (CUA) holders. Most of the commercial uses involve backcountry guiding services that operate under CUAs. In addition, there are seven rafting outfitters that operate on the Skagit River, and four outfitters that provide paddling (kayak and/or canoe) services on Ross Lake. One-third to one-half of all CUA holders are nonprofit organizations.

Concessions differ from CUA holders because they take place under a competitively awarded contract with the NPS. CUA operations take place entirely on NPS land, and funds are exchanged essentially within the park. They often own structures and buildings on NPS land. The only concession service on the west side of the park is Ross Lake Resort on Ross Lake. The resort originally centered around fishing on Ross Lake, but as the quality of the fishery on Ross Lake declined in the 1970s and 1980s, the Ross Lake Resort expanded its services to accommodate nonangling clientele. Services now include lodging, water taxis, and boat rentals. There are three concessions in the community of

Stehekin, including the Stehekin Lodge, the House that Jack Built (a community craft cooperative), and MacGregor Mountain Outdoor Supply. The latter provides a variety of outdoor equipment, including fishing supplies.

There are no concessions or CUA holders in the North Cascades Complex that provide services exclusively related to sport fishing in mountain lakes, although fishing is part of many activities that are provided by backcountry guide and stock services as part of the overall trip experience. For example, Cascade Corrals, a horse-packing service based out of Stehekin, operates under a CUA and provides day trips to Coon Lake. On these trips, sport fishing is one of many activities that take place as part of the overall trip experience.

ENFORCEMENT

The Visitor Safety and Resources Protection Division shoulders a variety of management responsibilities that include Search and Rescue and law enforcement. Regarding law enforcement, the philosophy is to use the most minimum tool necessary to gain compliance with federal and state laws and regulations. The NPS law enforcement jurisdiction in the North Cascades Complex is proprietary, meaning that it reserves the right to regulate as a landowner, but the state of Washington retains predominant rights. Proprietary jurisdiction allows the NPS to assimilate state law in accordance with 36 CFR Part II. NPS Law Enforcement Rangers and WDFW Game Wardens jointly enforce regulations governing fish and wildlife. The most common legal violation in the North Cascades Complex is failure to secure a permit for backcountry camping. Poaching of plants and wildlife is also a common problem.

PARK FUNDING

As shown in table 30, funding for operations and programs in the North Cascades Complex has remained relatively steady over the past 10 years at approximately $5.5 million per year. Referred to as "base funding," each year NPS units receive funds to, among many things, operate the park, pay salaries, undertake maintenance projects, and administer natural and cultural resource protection programs. Overall, base funding for NPS units has not increased substantially and is expected to remain at current levels in the future.

CURRENT COST OF THE FISHERY MANAGEMENT PROGRAM

The costs of continuing to manage mountain lakes under alternative A would be primarily associated with stocking, very limited monitoring, and project oversight. These actions would cost approximately $18,000 per year and primarily be borne by the WDWF (WDFW, M. Downen, pers. comm., 2004). See the "Management and Operations" section in the "Environmental Consequences" chapter for the estimated costs to implement each alternative.

TABLE 30: ESTIMATED BASE FUNDING FOR THE NORTH CASCADES COMPLEX*

Fiscal Year	Estimated Increase in Base Funding	Estimated Base Funding
1993	No base increase	$4,864,000
1994	$400,000 base increase	$5,264,000
1995	No base increase	$5,264,000
1996	No base increase	$5,264,000
1997	No base increase	$5,264,000
1998	$275,000 base increase	$5,539,000
1999	No base increase	$5,539,000
2000	No base increase	$5,539,000
2001	No base increase	$5,539,000
2002	No base increase	$5,539,000
2003	No base increase	$5,539,000
2004	Requested $350,000	$5,889,000

Note:

* Base funding would not be the primary source of funds for implementation of the fishery management plan. For more details on cost of implementation, see the “Management and Operations” section in the “Environmental Consequences” chapter.

Canada
Mt. Baker Wilderness
Mt. Shuksan
North C
Nationa
(north
Baker Lake
Skagit River
Marblemount
Sauk River
Suiattle River
Darrington
Boulder River Wilderness
0
5
10
20

Environmental Consequences

Welcome

You are now in the "Environmental Consequences" chapter. Here are the topics you can read about.

INTRODUCTION 235

GENERAL METHODOLOGY FOR ESTABLISHING IMPACT THRESHOLDS AND MEASURING EFFECTS BY RESOURCE 237

AQUATIC ORGANISMS 243

WILDLIFE 278

SPECIAL STATUS SPECIES 294

VEGETATION 335

CULTURAL RESOURCES 350

VISITOR USE AND EXPERIENCE 369

HUMAN HEALTH 418

SOCIOECONOMIC RESOURCES 425

MANAGEMENT AND OPERATIONS 434

SUSTAINABILITY AND LONG-TERM MANAGEMENT 447

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES 450

ADVERSE IMPACTS THAT COULD NOT BE AVOIDED 452

INTRODUCTION

This "Environmental Consequences" chapter analyzes both beneficial and adverse impacts that would result from implementing any of the alternatives described in this *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS). In addition, this chapter includes a summary of laws and policies relevant to each impact topic, definitions of impact "thresholds" (for example, negligible, minor, moderate, and major), methods used to analyze impacts, and the analysis methods used for determining cumulative effects. As required by the Council on Environmental Quality (CEQ) regulations implementing the *National Environmental Policy Act* (NEPA), a summary of the environmental consequences for each alternative is provided in table 15, which can be found in the "Alternatives" chapter. The resource topics presented in this chapter, and the organization of the topics, correspond to the resource discussions contained in the "Affected Environment" chapter.

SUMMARY OF LAWS AND POLICIES

Three overarching environmental protection laws and policies guide the actions of the National Park Service (NPS) in the management of the parks and their resources—the *Organic Act of 1916*, NEPA and its implementing regulations, and the *Omnibus Management Act*. For a complete discussion of these and other guiding regulations, refer to the section titled "Related Laws, Policies, Plans, and Constraints" in the "Purpose of and Need for Action" chapter. These guiding regulations are described in brief below.

> The *Organic Act of 1916* (16 USC 1) commits the NPS to making informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.
>
> The *National Environmental Policy Act of 1969* is implemented through regulations of the CEQ (40 CFR 1500–1508). The NPS has, in turn, adopted procedures to comply with NEPA and CEQ regulations, as found in *Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision-making* (NPS 2001b) and its accompanying handbook.
>
> The *Omnibus Management Act* (16 USC 5901 et seq.) underscores NEPA in that both are fundamental to park management decisions. Both acts provide direction for connecting resource management decisions to the

> analysis of impacts and communicating the impacts of these decisions to the public, using appropriate technical and scientific information. Both acts also recognize that such data may not be readily available, and they provide options for resource impact analysis should this be the case.
>
> Section 4.5 of *Director's Order 12* adds to this guidance by stating, "when it is not possible to modify alternatives to eliminate an activity with unknown or uncertain potential impacts, and such information is essential to making a well-reasoned decision, the National Park Service will follow the provisions of the CEQ regulations (40 CFR 1502.22)." In summary, the NPS must state in an environmental assessment or impact statement (1) whether such information is incomplete or unavailable; (2) the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment; (3) a summary of existing credible scientific adverse impacts that is relevant to evaluating the reasonably foreseeable significant adverse impacts; and (4) an evaluation of such impacts based on theoretical approaches or research methods generally accepted in the scientific community.

Collectively, these guiding regulations provide a framework and process for evaluating the impacts of the alternatives proposed in this plan/EIS.

GENERAL METHODOLOGY FOR ESTABLISHING IMPACT THRESHOLDS AND MEASURING EFFECTS BY RESOURCE

The general approach for establishing impact thresholds and measuring the effects of the alternatives on each resource category includes the following elements:

general analysis methods as described in guiding regulations

basic assumptions used to formulate the specific methods used in this analysis

thresholds used to define the level of impact resulting from each alternative

methods used to evaluate the cumulative effects of each alternative in combination with unrelated factors or actions affecting park resources

methods and thresholds used to determine if impairment of specific resources would occur under any alternative

These elements are described in the following sections.

GENERAL ANALYSIS METHODS

The analysis of impacts follows CEQ guidelines and *Director's Order 12* procedures (NPS 2001b) and is based on the underlying goal of conserving biological integrity in the mountain lake ecosystem. One hallmark of this analysis is the application of results of the scientific research conducted in the North Cascades National Park Service Complex (North Cascades Complex) along with the other best available scientific literature applicable to the region and setting, the species being evaluated, and the actions being considered in the alternatives. A substantial amount of research has been conducted to answer many of the key questions about impacts on the natural resources of the North Cascades Complex. In addition, there is a substantial body of research conducted on similar questions in other national parks and natural areas. For some species or species groups in question, a large number of other studies have been conducted in the region or the range of the species. Other research and publications address broader ecological issues or landscape-level analysis.

The North Cascades Complex has been compiling spatial data that includes the recorded distribution of various organisms and landscapes. That database has been added to, refined, and cross-checked during the impact analysis, and compatible data from other research has been used in conjunction with data from the North Cascades Complex.

The NPS created an interdisciplinary planning team (also referred to as the Technical Advisory Committee) comprised of NPS staff from the North Cascades Complex, NPS Fisheries Program staff, NPS Environmental Quality Division, the Washington Department of Fish and Wildlife (WDFW), and other individual resource specialists assisting the NPS with preparation of this plan/EIS. The team also consulted with various experts in the field of fisheries management and other applicable scientific studies. The committee met periodically throughout the analysis and provided important input to the impact analysis.

The Technical Advisory Committee provided recommendations to managers of the North Cascades Complex on matters regarding the mountain lakes fishery, ecosystem status, and the analysis approach for this plan/EIS.

For each resource topic addressed in this chapter, the applicable analysis methods are discussed under each resource section.

ASSUMPTIONS

Several guiding assumptions were made to provide context for this analysis. These assumptions are described below.

ANALYSIS PERIOD

This plan/EIS establishes goals, objectives, and specific implementation actions needed to manage the mountain lakes fishery for the next 15 years; therefore, the analysis period used for assessing impacts is up to 15 years. The impact analysis for each alternative is based on the principles of adaptive management, which would allow the NPS and WDFW to change management actions as new information emerges through monitoring the results of management actions and ongoing research throughout the life of this plan/EIS.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

The geographic study area for this plan/EIS includes all three administrative units of the North Cascades Complex. However, the focus of this document is the 91 mountain lakes in the North Cascades Complex that have a history of fish presence (refer to "Map 1" and the "Map 1 Table" located in the envelope that accompanied this document). While management actions are applied to 91 lakes in this plan/EIS, the analysis area for analyzing impacts includes streams and other lakes connected to the 91 lakes, the terrestrial and cultural resources surrounding the lakes, and communities in the vicinity of these lakes.

DURATION AND TYPE OF IMPACTS

For the purpose of the analysis provided in this plan/EIS, the following assumptions are used for all impact topics (the terms "impact" and "effect" are used interchangeably throughout this document):

> *Short-term impacts*: Those occurring from fishery management actions in the immediate future.
>
> *Long-term impacts*: Those occurring from fishery management actions over several seasons through the next 15 years and beyond.
>
> *Direct impacts*: Those occurring as a direct result of fishery management actions, including lake treatment methods.
>
> *Indirect impacts*: Those occurring from fishery management actions that would indirectly alter a resource or condition.

FUTURE TRENDS

Visitor use and demand are anticipated to follow trends similar to recent years. Visitation to the North Cascades Complex has fluctuated slightly, but generally remained at an average of 412,012 people per year between 1996 and 2002.

In the absence of notable anticipated changes in facilities or access, the average visitation is expected to continue and be reflected across user groups.

IMPACT THRESHOLDS

Determining impact thresholds is a key component of *NPS Management Policies* (NPS 2001a) and the *Director's Order 12* handbook (NPS 2001b). These thresholds provide the reader with an idea of the intensity of a given impact on a specific topic. The impact threshold is determined primarily by comparing the impact to a relevant standard from state or federal regulations or scientific research. Because definitions of intensity vary by impact topic, intensity definitions are provided separately for each impact topic analyzed in this document. The following intensity definitions are used throughout this analysis: negligible, minor, moderate, and major.

CUMULATIVE EFFECTS ANALYSIS METHOD

The CEQ regulations that implement NEPA require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for all alternatives, including the no-action alternative (alternative A).

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. The following points attempt to clarify potential cumulative impact issues in the vicinity of the North Cascades Complex:

No projects are proposed or in planning stages that would change the road access to any unit of the North Cascades Complex.

No new major trails or trailheads are being considered; however, a small section of the Pacific Northwest Trail within the North Cascades Complex is currently under construction.

No new resorts or major upgrades of existing facilities are being planned. Visitor use is expected to follow the same patterns that it has for several years.

A climbing management plan is expected in the winter of 2004.

The park experienced flooding in the fall of 2004, and trails, roads, and bridges were destroyed.

There would be continued logging activities proximate to the park.

Dam and reservoir operation that has occurred and continues to occur outside the North Cascades Complex would have ongoing effects.

There would be continued human recreational use (by anglers, visitors using pack animals [horses, mules, llamas], hikers, and campers) of the lakes in the study area and surrounding drainages. The level of use is expected to follow recent average visitation.

There would be a continued presence of fish in lakes located on lands surrounding the North Cascades Complex, but these lakes are not connected upstream to lakes in the study area. A drop-down of fish from lakes outside the North Cascades Complex is not expected.

There is the potential for increased acid rain from emissions related to the development of an additional power plant in the area.

There would be continued natural impacts (such as erosion, general weathering, drought, and flooding).

There would be continued disturbance to ground resources due to inadvertent ground disturbance, vandalism, artifact collection, and digging.

Based on trends, the economy in communities surrounding the North Cascades Complex would continue to evolve as industry diversification occurs.

Park operations costs, in general, are expected to increase based on recent trends.

The WDFW manages mountain lake fisheries on lands administered by the U.S. Forest Service that surround the North Cascades Complex. The WDFW management approach, described in "A Report on the Washington Department of Fish and Wildlife's High Lakes Fishery Management Program" (WDFW 2001), is expected to be similar in the foreseeable future to what is currently being done.

IMPAIRMENT ANALYSIS METHOD

The "Purpose of and Need for Action" chapter describes the related federal acts and policies regarding the prohibition against impairing park resources and values in units of the national park system.

An action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS 2001a, 1.4.4). To determine impairment, the NPS must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (NPS 2001a, 1.4.4).

NPS units vary based on their enabling legislation, natural and cultural resources present, and park missions; likewise, the recreational activities appropriate for each unit and for areas in each unit vary as well. For example, an action appropriate in one unit would impair resources in another unit. Thus, this plan/EIS analyzes the context, duration, and intensity of impacts of the alternatives as well as potential for resource impairment, as required by *Director's Order #12: Conservation Planning, Environmental Impact Analysis and Decision-making* (NPS 2001b). An impact on any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major adverse impact upon a resource or value whose conservation is necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park

key to the natural or cultural integrity of the park

identified as a goal in the park's general management plan or other relevant NPS planning documents

The following process was used to determine whether the various fishery management alternatives had the potential to impair park resources and values:

Step 1. The enabling legislation, *General Management Plan* (NPS 1988b), *Strategic Plan* (NPS 2000a), and other relevant background information for the North Cascades Complex were reviewed to ascertain its purpose and significance, resource values, and resource management goals or desired future conditions.

Step 2. Resource protection goals were identified.

Step 3. Thresholds were established for each resource of concern to determine the context, intensity, and duration of impacts, as defined earlier in this chapter in the section titled "Impact Thresholds."

Step 4. An analysis was conducted to determine if the magnitude of impact would constitute an "impairment," as defined by *NPS Management Policies* (NPS 2001a).

The impact analysis includes findings of impairment of park resources for each of the management alternatives. Impairment findings are made for park resources affected by the alternatives. Park operations and management, socioeconomics, and visitor use are not considered park resources; therefore, impairment findings are not included as part of the impact analysis for these topics.

AQUATIC ORGANISMS

The aquatic organisms potentially affected by the proposed alternatives include plankton, macroinvertebrate, and amphibian species that are naturally occurring in mountain lakes in the North Cascades Complex, as well as native fish species in drainages downstream from the lakes. It is recognized that actions proposed under the various alternatives would also have direct impacts on the stocked fish themselves, due to a reduction or elimination of selected populations. Stocked fish are nonnative species that were stocked specifically for recreational purposes; therefore, impacts on stocked fish are not analyzed in detail here, but their value to the mountain lakes fishery is addressed in the section titled "Visitor Use and Experience" later in this chapter.

Aquatic insects, known as macroinvertebrates, are important food sources for the many species of fish that dwell in the rivers and lakes in the North Cascades Complex and are also important as indicators of water quality and habitat condition.

This section explains the methods used to analyze impacts on aquatic organisms, presents the results of analysis, and describes the guiding regulations and policies, as well as the basic assumptions and thresholds used in the analysis.

GUIDING REGULATIONS AND POLICIES

The *General Management Plan* (NPS 1988b) includes management objectives that are relevant to overall natural resources in the North Cascades Complex, including aquatic organisms. The *General Management Plan* includes the following objectives:

> To increase knowledge and understanding of the interrelationships of the natural processes, and of methods for implementation of appropriate actions.
>
> To preserve, maintain, or restore, where feasible, the primary natural resources and ecological relationships and processes.
>
> To manage the natural resources as an integral part of a regional ecosystem.
>
> To provide opportunity for research in as natural a system as possible.

The *Strategic Plan* (NPS 2000a) also includes mission goals for preserving park resources that are consistent with the goals and objectives of this analysis. Mission Goal I.a. provides for the following desired condition: "Natural and cultural resources and associated values of the North Cascades National Park Service Complex are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context."

Servicewide NPS regulations and policies, such as the *Organic Act of 1916*, *NPS Management Policies* (NPS 2001a), and Reference Manual 77: *Natural Resource Management*, also direct parks to provide for the protection of park resources. Broadly stated, these policies require the NPS to manage natural resources in a manner that will maintain, rehabilitate, and perpetuate the inherent integrity of water resources and aquatic systems. In summary, the NPS seeks to

eliminate human-induced impacts on aquatic habitats

limit effects and mitigate damage if impacts are unavoidable

maintain and restore aquatic habitats to protect their ecological and aesthetic character and dependent plant and animal communities

METHODOLOGY AND ASSUMPTIONS

The following section describes the methodology used to evaluate the impacts of the proposed alternatives on aquatic organisms. Impacts were assessed by considering the major issues identified, examining the existing data and literature, and applying professional judgment. Key components of the methodology include assumptions made about the extent of the geographic area evaluated for impacts, the outcomes of the management actions, and the criteria used to evaluate impacts and define impact thresholds for aquatic organisms.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

For the purpose of this analysis, the area evaluated for impacts on aquatic organisms includes the 91 naturally formed mountain lakes in the North Cascades Complex that currently have, or one time had, a fish presence as a result of either documented or undocumented fish stocking activities, as described in the "Purpose of and Need for Action" chapter. In the case of stocked nonnative fish dispersing downstream and potentially affecting native fish species, impacts in downstream drainage basins that extend outside the North Cascades Complex are also considered. These drainages include the Chilliwack River (Fraser River Basin), Lake Chelan Basin (includes the Stehekin River and its tributaries), and the Skagit River and several of its tributaries.

OUTCOMES OF THE MANAGEMENT ACTIONS

Several of the management actions that would be applied to lakes under each of the action alternatives would potentially have multiple outcomes depending on the results of adaptive management decisions. Therefore, for the purpose of this analysis, the focus is on the initial outcome of management actions and the assumption that the lakes would either have fish or not have fish, based on the initial results of the actions taken. However, it is recognized that these conditions may change in some of the lakes due to decisions made in the proposed mountain lakes fishery monitoring plan (see appendix F). If future monitoring indicates that fish presence has caused unacceptable changes to native biota, and as a result fish are removed or fish populations are reduced, impacts may also be reduced from what is presented here.

IMPACT CRITERIA AND METHODOLOGY

Information and input from a number of sources were considered during the public scoping process. Site-specific research data on the effects of fish stocking in North Cascades Complex lakes, as well as additional literature from studies in other alpine lake systems, were considered. A concern identified during public scoping was that people recognize the adverse impacts on native species in mountain lakes from the widespread practice of fish stocking. While fish stocking has acknowledged benefits, it can also have negative impacts under certain circumstances when nonnative species are stocked, which can result in a loss of ecological integrity.

The methods used to evaluate impacts on aquatic organisms focus on the direct and indirect effects of fish populations in mountain lakes, primarily predation and competition for prey, effects on food webs and nutrient cycling, and effects on native fish resulting from potential downstream colonization by stocked species. Both population and community levels were considered. A population is defined as the group of individuals within a given species that are reproductively isolated from other groups and have geographically defined distributions. Communities are defined as the interacting populations of all species within a resource category.

For many aquatic species, such as macroinvertebrates and amphibians, the extent of geographic distribution is best described as a metapopulation. This is a cluster of geographically discrete populations that are connected by infrequent, but critical, interbreeding and genetic exchange with nearby populations. For example, the geographic extent of a population of aquatic macroinvertebrates with a flying adult phase, such as caddisflies (*Trichoptera*), is generally determined by drainage basin boundaries. However, adult caddisflies from one population may frequently disperse to other drainage basins and interbreed with other populations, forming a metapopulation relationship. Recolonization of suitable habitats where populations are no longer present occurs through similar mechanisms. In contrast, populations of purely aquatic zooplankton, such as large copepods, are limited to individual lakes or lake clusters that are immediately adjacent to each other.

Metapopulation: Geographically separate populations of the same species connected by infrequent, but critical, interbreeding.

The units of impact analysis for each group of aquatic organisms are described below by resource category.

Plankton. Effects on plankton are evaluated at both the population and community levels, with emphasis on the effects on larger copepod zooplankton that are the primary prey species of fish. The plankton community is composed of a complex of populations of individual species of both phytoplankton and zooplankton that occupy different trophic levels.

Macroinvertebrates. Effects on macroinvertebrates are evaluated at both the population and community levels, with emphasis on the primary prey species of aquatic insects. The macroinvertebrate community is composed of a range of insect, mollusk, flatworm, nematode, and other species occurring in each lake. Some macroinvertebrate species, including aquatic insects, have metapopulations that are considered in the analysis.

Amphibians. Effects on amphibians are evaluated at the population level, with emphasis on the effects on the long-toed salamander, an indicator species that is particularly sensitive to fish presence, and the Northwestern salamander, another species often found in different lakes than the long-toed salamander. The population structure of amphibians varies by species, depending on breeding range, adult habitats, and ability to disperse. Metapopulations are important considerations in the analysis.

Fish. Impacts on native fish in downstream drainages are evaluated at the population level, for the potential of nonnative trout stocked in mountain lakes to establish reproducing "naturalized" populations in streams, where they can affect native fish by predation, hybridization, or competition for available habitat and resources. The distribution of native fish in basins potentially affected by trout introduced to mountain lakes was determined through literature reports of native fish distribution (WDFW 2003; Cutler 2001; Smith 2002; Wydoski and Whitney 2003) and consultation with WDFW biologists (WDFW, M. Downen, pers. comm., 2004; WDFW, B. Pfeifer, pers. comm., 2004).

IMPACT THRESHOLD DEFINITIONS

Four separate sets of impact thresholds, ranging from negligible to major intensity, were defined to address potential impacts on the plankton, macroinvertebrates, and amphibians in the mountain lakes and native fish in downstream drainages. Because there is incomplete knowledge of the actual impacts that are occurring or would occur in all 91 lakes under all four alternatives, impact thresholds were developed using predictive factors that have been shown to affect the distribution and viability of these organisms. These factors were identified from a review of scientific literature and past research. For example, past research results indicate that total Kjeldahl nitrogen (TKN) and lake connectivity are important predictive factors relating to impacts on amphibians.

In addition to predictive factors, data and professional knowledge supplied by NPS and WDFW staff involved in preparing this plan/EIS were used to arrive at impact intensities, whenever possible. The assessment was done on a lake-by-lake basis, using impact thresholds based on both the predictive factors and actual knowledge of site conditions, to arrive at a final impact level for each lake and associated downstream drainage.

Because the impact thresholds used are complex and technical, appendix G provides an expanded, detailed discussion of the scientific background material that was the basis for impact threshold development. Appendix G also includes tables that show the analysis and impact results on a lake-by-lake basis for each group of aquatic organisms (see tables G-1, G-2, G-4, and G-5). A summary of the impact thresholds and the main factors considered in their development is provided in table 31.

TABLE 31: SUMMARY OF IMPACT THRESHOLDS – AQUATIC ORGANISMS[a]

Primary Predictive Factors[b] Affecting Impact Levels	Impact Intensity			
	Negligible	Minor	Moderate	Major
Plankton (primarily large zooplankton species)				
• Fish density[c] (higher trout densities may result in greater predation of zooplankton) • Lake depth (plankton can escape predation in deeper lakes) • Lake area (plankton can escape predation in larger lakes) • Professional knowledge of study area lakes • Impacts on larger zooplankton (copepods) are of primary concern since they are more susceptible to predation by fish than are small zooplankton.	Long-term adverse impacts would potentially be negligible even though these lakes have historically been stocked. Abundance and community structure would be expected to be influenced primarily by biogeographical and evolutionary processes. For this assessment, negligible impacts on the zooplankton community would be expected in a lake where the following predictive factor is found: • Lake was previously stocked but is currently fishless	Minor changes in community structure would potentially occur. If fish were removed or died off, the community structure would become comparable to currently fishless lakes. For this assessment, minor impacts on the zooplankton community would be expected in a lake where the following predictive factors are found: • Lake depth >50 ft., OR • Lake area >40 ac., OR • Fish density is low (stocked trout at <100 fish/acre or reproducing trout at <50 trout/acre)	Noticeable changes in community structure would potentially occur, and large copepod abundance would be greatly reduced. If fish were removed or died off, the relative abundance of large copepods would increase. For this assessment, potentially moderate impacts on large zooplankton would be expected in a lake where the following predictive factors are found: • Lake depth <50 ft. AND • Lake area <40 ac. AND Fish density is high (reproducing trout at 50 fish/acre)	Significant changes in community structure would potentially occur, and large copepod abundance would be reduced significantly such that they are undetectable. If fish were removed or died off, the community structure may not become comparable to currently fishless lakes. For this assessment, potentially major impacts on large zooplankton would be expected in a lake where the following predictive factors are found: • Lake depth <50 ft. AND Lake area <40 ac. AND Fish density is very high (reproducing trout or multiple age classes at >400 fish/acre)
Macroinvertebrates (primarily aquatic insects – mayflies, stoneflies, caddisflies, and midges)				
• Fish densityc (higher trout densities result in greater predation of macroinvertebrates) • Lake area (macroinvertebrates can escape predation in larger lakes) • Professional knowledge of study area lakes (especially the presence/absence of habitat complexity)	Community structure would be comparable to fishless lakes with similar physical/chemical characteristics. Abundance and community structure would be expected to be influenced primarily by biogeographical and evolutionary processes. For this assessment, negligible impacts on the macroinvertebrate community would be expected in a lake where the following predictive factor is found: • Lake was previously stocked but is currently fishless	Minor changes in community structure in a lake would potentially occur; although populations would recover if fish were removed. For this assessment, minor impacts would be expected where the following predictive factor is found: • Fish density is low (stocked trout at <100 fish/acre)	Moderate changes in community structure and functional group composition in a lake would potentially occur, relative to currently fishless but otherwise similar lakes. Populations eventually would recover from impacts if fish were removed. For this assessment, moderate impacts would be expected where the following predictive factors are found: • Fish density is high (stocked trout at >100 fish/acre or reproducing trout at >50 fish/acre)	Major impacts resulting from high fish densities would include absence of more than 40% of taxa expected to commonly occur in fishless lakes of similar environmental characteristics. Additionally, significant changes in dominant taxa and functional feeding group composition also would occur. Recolonization might not occur for an extended period of time without active intervention. For this assessment, major impacts would be expected where the following predictive factors are found:

TABLE 31: SUMMARY OF IMPACT THRESHOLDS – AQUATIC ORGANISMS[a] (CONTINUED)

Primary Predictive Factors[b] Affecting Impact Levels	Impact Intensity			
	Negligible	**Minor**	**Moderate**	**Major**
Macroinvertebrates (continued) (primarily aquatic insects – mayflies, stoneflies, caddisflies, and midges)				
			AND Lake area >10 acres OR • Lake area <10 acres with high habitat complexity	• Fish density is high (stocked trout at >100 fish/acre or reproducing trout at >50 fish/acre) AND Lake area <10 acres often with limited habitat complexity
Amphibians (represented by long-toed salamanders and Northwestern salamanders)				
• Fish density[c] (higher trout densities result in greater predation of amphibians) • Presence of nearby forested habitat suitable for either principal species of interest: long-toed salamanders – open terrain at the lake with forest nearby; Northwestern salamanders - dense, closed-canopy forest • TKN[d] levels (higher TKN means higher lake productivity that, in turn, correlates with more long-toed salamanders) • Degree to which lakes are connected (higher Index of Connectivity [IOC][e] means lakes are more connected and can therefore more easily recolonize and recover from impacts) • Professional knowledge of study area lakes • Impacts on long-toed salamanders are of primary concern because of their sensitivity to fish predation	Populations likely would be present in any lake in historic range, with larval density close to that of fishless lakes. For this assessment, negligible impacts on long-toed salamanders would be expected where the following predictive factors are found: • Lake with suitable habitat is within their range AND TKN ≥ 0.045 mg/L, fish density is low, and IOC ≥ 0.4 OR • Lake with suitable habitat is within their range AND TKN < 0.045 mg/L and fish density is low OR • Lake with suitable habitat is within their range AND TKN < 0.045 mg/L, fish density is high, and IOC ≥ 0.7	Populations likely would be present in their historic range, but density of larvae in a lake would potentially be slightly smaller than comparable fishless lakes. For this assessment, minor impacts on long-toed salamanders would be expected where the following predictive factors are found: • Lake with suitable habitat is within their range AND TKN ≥ 0.045 mg/L, fish density is low, and IOC < 0.3 Minor impacts on Northwestern salamanders may occur when the following predictive factors are found: • Lake with suitable habitat is within their range AND Stocked fish density is low	Populations would be present in the historic range, but density of larvae in a lake would potentially be smaller than comparable fishless lakes, and populations may be eliminated on a temporary or local basis. Populations would deviate from normal levels. For this assessment, potentially moderate impacts on long-toed salamanders would be expected where the following predictive factors are found: • Lake with suitable habitat is within their range AND TKN ≥ 0.045 mg/L, fish density is high, and IOC ≥ 0 OR • Lake with suitable habitat is within their range AND TKN < 0.045 mg/L, fish density is high, and IOC = 0.4–0.6	Populations of long-toed salamanders would be permanently altered from normal levels, and possibly eliminated from a lake, with recolonization unlikely. For this assessment, potentially major impacts on long-toed salamanders would be expected where the following predictive factors are found: • Lake with suitable habitat is within their range AND TKN ≥ 0.045 Mg/L, fish density is high, and IOC < 0 OR • Lake with suitable habitat is within their range AND TKN < 0.045 mg/L, fish density is high, and IOC ≤ 0.3 Major impacts on Northwestern salamanders are unlikely in any lake due to larger larvae and behavioral adaptations for avoiding predation

TABLE 31: SUMMARY OF IMPACT THRESHOLDS – AQUATIC ORGANISMS[a] (CONTINUED)

Primary Predictive Factors[b] Affecting Impact Levels	Impact Intensity			
	Negligible	Minor	Moderate	Major
Amphibians (continued) (represented by long-toed salamanders and Northwestern salamanders)				
			Moderate impacts on Northwestern salamanders may occur when the following predictive factors are found: • Lake with suitable forested habitat is within their range AND Fish density is high	
Native Fish				
• Connections to downstream streams and creeks containing native fish (there must be a connection for impacts on occur) • Particular fish species/strains present (some, like brook trout, are more aggressive; some like Mt. Whitney and California golden trout, do not readily colonize downstream areas; some are not able to interbreed) • Specific professional (primarily WDFW) knowledge of potentially affected outlet stream reaches	If present in a lake with an outlet, fish are either native to basin or are unlikely to colonize downstream areas if one or more of the following predictive factors apply. • Ross Lake or Mt. Whitney rainbow trout, coastal cutthroat trout, or California golden trout are present in a west-side lake OR • Westslope cutthroat trout are present in an east-side lake OR • The lake is fishless	Relatively small numbers of individuals would potentially be affected through intra-species hybridization. Outbreeding depression may occur in vicinity of outlet stream, but effects would be localized. All native species would be indefinitely viable. For this assessment, potentially minor impacts would be expected when a surface outlet connects to a downstream basin AND one of the following additional predictive factors is found: • Reproducing strains or subspecies of rainbow or cutthroat trout not native to basin are present in a west-side lake OR • Mt. Whitney rainbow trout are stocked in an east-side lake	Although individuals of non-native species stocked in a lake would occasionally disperse downstream and rear in streams, there would be no measurable evidence of colonization or hybridization with native fish. All native species would be indefinitely viable. For this assessment, potentially moderate impacts would be expected when a surface outlet connects to a downstream basin AND the following additional predictive factors are found: • Inventories demonstrate that colonization and/or hybridization of the outlet stream has not occurred from populations of nonnative stocked fish that have a long history of high levels of reproduction AND • Reproducing brook trout are present in a west-side lake OR • Reproducing rainbow trout or rainbow/cutthroat hybrids are present in an east-side lake	There would be measurable evidence of colonization, and where interbreeding is possible, hybridization with native fish. Native species deviate from normal population levels or abundance and/or genotypes are permanently altered. On a local basis, native species may be eliminated or become hybrid swarms. For this assessment, potentially major impacts would be expected when a surface outlet connects to a downstream basin AND the following additional predictive factors are found: • Inventories demonstrate colonization and hybridization of the outlet stream from downstream dispersal of nonnative stocked fish have occurred AND Reproducing brook trout are present in a west-side lake OR • Reproducing rainbow trout or rainbow/cutthroat hybrids are present in an east-side lake

TABLE 31: SUMMARY OF IMPACT THRESHOLDS – AQUATIC ORGANISMS^{a} (CONTINUED)

Notes:

a. For detailed thresholds and background information about their development, see appendix G.

b. Predictive Factors = Physical, chemical, and biological factors are used in this assessment as surrogates indicative of potential impacts on organisms. Where data are not available, depth and TKN values are estimated from knowledge of similar nearby lakes.

c. Low fish density ≤ 100 trout/acre for stocked fish or < 50 trout/acre for reproducing fish.

High fish density ≥ 100 trout/acre for stocked fish or > 50 trout/acre for reproducing fish.

Very High fish density ≥ 400 trout/acre of reproducing fish or stocked fish with multiple-year classes approximating age structure of reproducing fish.

d. TKN = Total Kjeldahl nitrogen (combined measurement of ammonia and organic nitrogen).

e. IOC = Index of Connectivity (based on the number of known salamander populations within 3.75 miles and the number of potential long-toed salamander breeding ponds within 0.4 mile).

Symbols:

< = less than

> = greater than

• = greater than or equal to

" = less than or equal to

In addition to discussing impacts related to stocking, the analysis also provides a discussion of impacts related to proposed lake treatment methods. For these impacts, no specific impact threshold definitions were developed; rather, these effects were evaluated using literature review, professional experience, and best professional judgment. Similarly, beneficial effects that are not defined in the thresholds are identified where appropriate, using best professional judgment.

In all cases, an evaluation of impairment was performed, as described below, to determine if any major impacts would be considered an impairment.

Impairment. Major impacts on an aquatic resource or value that, due to its severity, duration, and/or timing, would result in the elimination of an aquatic species in the North Cascades Complex or would result in significant population declines in an aquatic species. In addition, these major adverse impacts on North Cascades Complex resources and values would

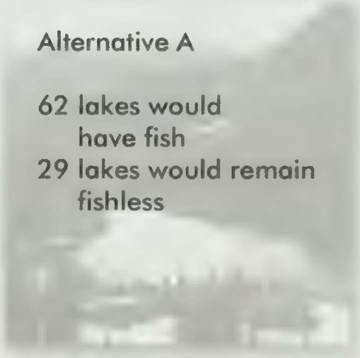
> contribute to deterioration of aquatic resources and values to the extent that the purpose of the North Cascades Complex would not be fulfilled as established in its enabling legislation
>
> affect resources key to the natural or cultural integrity or opportunities for enjoyment in the North Cascades Complex
>
> affect the resource whose conservation is identified as a goal in the *General Management Plan* (NPS 1988b) or other planning documents for the North Cascades Complex

IMPACTS OF THE ALTERNATIVES ON AQUATIC ORGANISMS

This section addresses impacts that would result from the implementation of the management actions for each of the lakes under each alternative; the impacts are related to the numbers of stocked or reproducing fish that would remain in the subject lakes and to any treatment method used to remove fish (except for alternative A because no lakes are currently treated for fish removal). Table 32 summarizes the predicted impact levels by alternative for each group of aquatic organisms (by numbers of lakes) related solely to the management action outcomes.

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A would continue existing practices in the 91 lakes slated for management consideration in the study area. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.



Alternative A

62 lakes would have fish
29 lakes would remain fishless

TABLE 32: OUTCOMES OF APPLYING AQUATIC ORGANISM IMPACT THRESHOLDS (NUMBERS OF LAKES FALLING INTO THE DIFFERENT IMPACT THRESHOLDS UNDER EACH ALTERNATIVE)

Plankton	Alternative A	Alternative B	Alternative C	Alternative D
Major	1[a]	0	0	0
Moderate	13	0	0	0
Minor	48	29	9	0
Negligible	29	62	82	91

a. Blum (Lower/West No. 4) Lake: Major impact based on very high fish density, 25.9 foot depth, 6.4 acre area.

Macroinvertebrates	Alternative A	Alternative B	Alternative C	Alternative D
Major	13[b]	0	0	0
Moderate	17	0	0	0
Minor	32	29	9	0
Negligible	29	62	82	91

b. These lakes include Battalion, Berdeen (Upper), Berdeen (Lower), Blum (Lower/West No. 4), Dee Dee (Upper), Diobsud No. 1, Diobsud No. 2 (Lower), Diobsud No. 3 (Upper), Doug's Tarn, Kettling, Stiletto, Triplet (Lower), and Wilcox/Sandie (Lower): Lakes with major impacts based on current monitoring data or predictive factors of high fish densities and relatively small lake areas.

Amphibians	Alternative A	Alternative B	Alternative C	Alternative D
Major	7[c]	0	0	0
Moderate	11	0	0	0
Minor	15	9	5	0
Negligible	58	82	86	91

c. These lakes include Battalion, Blum (Lower/West, No. 4), Blum (Largest/Middle, No. 3), Dee Dee (Upper), and Hanging: Major impacts based on high fish density, TKN <0.045 mg/L or unknown, Index of Connectivity (IOC) <0.3 or unknown (conservative estimates); plus Sourdough and Triplet (Lower) lakes: Major impacts based on high fish density, TKN >0.045 mg/L or unknown, IOC <0.

Native Fish	Alternative A	Alternative B	Alternative C	Alternative D
Major	1[d]	0	0	0
Moderate	9	0	0	0
Minor	26	7	1	0
Negligible	55	84	90	91

d. McAlester Lake: Major impacts based on presence of nonnative rainbows in east-side lake, with evidence of both colonization and hybridization (note: impacts on native westslope cutthroat trout are addressed in the "Special Status Species" section.

Impacts of Current Fish Stocking on Aquatic Organisms

Plankton. Under alternative A, the extent of impacts on the plankton community from stocking would vary considerably from lake to lake. Direct and indirect effects resulting from fish predation and changes in nutrient cycling would occur in varying magnitude in each lake, depending on the population characteristics (such as fish density and whether the lake is stocked or has mixed or reproducing populations) and the physical characteristics of each lake. Table 31 summarizes the thresholds used in identifying impact levels for plankton under each alternative, and appendix G provides a more detailed discussion about the predictive factors and the thresholds. Table G-1 in appendix G provides an assessment of impacts on plankton by lake for each alternative.

Plankton: "Free-floating" organisms that include phytoplankton (free-floating microscopic plants) and zooplankton (the animal counterparts of phytoplankton).

Copepod: A type of crustacean zooplankton that exhibits a wide variety of feeding preferences, even consuming other zooplankton. The larger copepods are an important component of the food base for larger vertebrate organisms such as larval amphibians and fish.

As shown in table 31, the primary concerns in the analysis of impacts on plankton are impacts on larger copepods, which tend to be more susceptible to predation by fish. Factors considered in the analysis include fish density (defined for both stocked and reproducing populations), lake depth, and lake area, as well as professional knowledge of the lakes and plankton dynamics.

Based on the thresholds established, only 1 of the 91 lakes in the study area would be expected to experience long-term, major, adverse impacts on plankton from current management actions. This is Blum (Lower/West No. 4), which has a very high density of reproducing fish and a relatively small size and depth (see table G-1 in appendix G). Research indicates that zooplankton species can be adversely affected by predation and changes in food web dynamics resulting from the introduction of fish, especially when high densities of reproducing fish are present. In some cases, it has been observed that fish stocking has resulted in the complete extirpation of some species, with larger copepods and cladocerans being the most vulnerable (Parker et al. 1996, 2001; Anderson 1972; Crumb 1978; Divens et al. 2001; Leavitt et al. 1994). However, research has shown that zooplankton were not extirpated in larger, deeper lakes (greater than 50 feet in depth), even lakes with high densities of stocked fish, because the deeper zones provide refuge habitat for the large copepod and cladoceran species that are most vulnerable to extirpation (Donald et al. 1994). Therefore, adverse impacts on plankton are more likely to be present and/or more severe in shallow lakes with very high fish densities, such as Blum (Lower/West No. 4).

Moderate long-term adverse impacts on plankton would be expected to occur in 14 of the 91 lakes in the study area. These 14 lakes have high fish densities (although not as high as seen in Blum Lower/West No. 4), are relatively shallow (less than 50 feet deep) or assumed to be shallow, and are relatively small (less than 40 acres). Impacts in these lakes would be similar to those expected in Blum (Lower/West No. 4) and would likely include a decrease in large copepod abundance, as well as changes in nutrient cycling and associated phytoplankton community changes. However, because the densities of fish in these 14 lakes are not extremely high, impacts would be considered moderate.

In 48 of the 91 lakes, impacts on plankton would be considered adverse, minor, and long term. Fourteen of the 48 lakes have high-density reproducing fish populations, but the lakes are sufficiently large and deep to provide refuge habitat. Lakes greater than 50 feet deep provide shelter for larger zooplankton, which limits the severity of impacts from introduced fish (Donald et al. 1994). The remainder of the 48 lakes support low-density stocked, mixed, or reproducing populations, which have been shown to have limited impacts on the plankton community. Several studies have shown that plankton can survive in lakes that contain lower densities of fish, especially if the fish are nonreproducing. Studies of mountain lakes in the Olympic and Cascade mountains found that one large zooplankton species continued to coexist with low densities of reproducing trout more than 20 years after the initial introduction (WESI 1993). Other studies have documented the coexistence of large diaptomids with low densities of reproducing salmonids (Hoffman and Pilliod 1999; Bahls 1990; Anderson 1972; McNaught et al. 1999). In the lakes with low-density populations of stocked fish, population structure and abundance may vary slightly for some plankton species because of the indirect effects of fish presence on food web dynamics and nutrient cycling. Populations of large zooplankton, which are preyed upon by stocked trout, may be slightly suppressed, but remain viable and healthy. Shifts in phytoplankton community structure resulting from fish stocking would persist, but it is unlikely that species would be eliminated, and the resilience and adaptive capacity of the community would be maintained. For these reasons, impacts on the plankton community in these 48 lakes would be considered minor.

Talus Tarn is one of the 29 currently fishless lakes that would remain fishless under all alternatives.

In the 29 fishless lakes, long-term adverse impacts on plankton would be considered negligible. These lakes were historically stocked with trout but currently have no fish populations. Research has shown that, with time, plankton communities can recover in lakes that have contained fish, and zooplankton can be effectively reintroduced (McNaught et al. 1999; Parker et al. 2001). Also, phytoplankton species generally are not lost entirely, although there may be a shift in species abundance and community structure that persists following fish removal (Drake and Naiman 2000). While community structure in these lakes may have shifted from historical conditions prior to fish stocking, the range of plankton species present and overall biomass and productivity in these 29 lakes would be expected to be comparable to those in similar, but otherwise fishless lakes. Therefore, residual adverse impacts of fish stocking in these lakes would be considered negligible because recovery has occurred. These lakes serve as a benchmark for expected conditions in lakes following a period of recovery after fish are removed.

Impairment of plankton species across the study area would not occur under alternative A.

Macroinvertebrates. The assessment of impacts on the macroinvertebrate community under alternative A was based primarily on fish density and lake area, relying heavily on the data and professional knowledge of NPS staff who have been monitoring macroinvertebrates in several study area lakes over several years (NPS, R. Glesne, pers. comm., 2004). Table 31 provides a summary of impact thresholds for macroinvertebrates, while appendix G provides additional background information used to develop the thresholds. Table G-2 in appendix G provides an assessment of impacts on macroinvertebrates by lake and by alternative.

In 13 of the 91 lakes, impacts on macroinvertebrates under alternative A are expected to be adverse, long term, and major. Four of these lakes are included in the current NPS benthic macroinvertebrate monitoring program. The major impact level for these four lakes was assigned based on monitoring data that shows an absence of more than 40% of the taxa expected to commonly occur in fishless lakes of similar environmental characteristics. For 9 of the 13 lakes, a major impact level was predicted due to the presence of high densities of nonnative fish (greater than 100 fish/acre for stocked lakes, greater than 50 fish/acre for lakes with reproducing fish), combined with a relatively small area (less than 10 acres) and a lack of complex habitat as defined and identified by NPS biologists familiar in this lake (NPS, R. Glesne, pers. comm., 2004). In these lakes, high densities of fish would result in more intense fish predation, which has been shown to result in substantial changes in abundance and biomass of some species, as well as phenotypic (visible characters of an organism) and behavioral changes (Chess et al. 1993; Knapp 1996; Luecke 1990; Walters and Vincent 1973). Some species may be depressed or even extirpated in some lakes.

In 17 of the 91 lakes, stocking would be expected to result in long-term, moderate, adverse impacts on macroinvertebrates. These lakes contain a high or very high density of stocked or naturally reproducing fish populations that prey on macroinvertebrates, but the lakes are larger (greater than 10 acres) and/or have a more complex or diverse habitat. Macroinvertebrate community structure in these 17 lakes would likely differ from fishless but otherwise similar lakes, as well as lakes with lower-density fish populations, but populations would recover if fish were removed.

In 32 of the 91 lakes, impacts on macroinvertebrates would be considered adverse, minor, and long term. These lakes have low-density stocked or mixed stocked/reproducing fish populations, which would have much reduced predation pressure on the macroinvertebrate community. Research has shown that while higher densities of stocked trout (716 to 1,790 fish/acre) can have substantial impacts on macroinvertebrate populations (Reimers 1958), lower densities of stocked trout (less than 100 fish/acre) have little effect on benthic fauna (Hoffman and Pilliod 1999). Predation and alteration of food web dynamics in these lakes would be expected to result in minor local reductions in macroinvertebrate abundance. Some shifts in community structure may also occur, but these would be minor relative to overall population structure.

In the 29 lakes that are now fishless, long-term adverse impacts on macroinvertebrates would be considered negligible. These lakes were historically stocked with trout but currently have no fish populations. Observed macroinvertebrate community structure and abundance in these lakes would be expected to be comparable to those in similar, but otherwise fishless lakes, indicating that a recovery has occurred. As the literature indicates, the primary prey macroinvertebrate species are relatively resistant to fish predation at the population and community levels in lake environments, with the exception of sensitive species such as phantom midges (*Chaoborus* spp.). As previously mentioned, affected species usually have a high dispersal potential, and therefore, lakes can be recolonized relatively quickly (Bilton et al. 2001; Bohonak and Jenkins 2003), so that the residual adverse effects of fish stocking in these lakes would be considered negligible.

Impairment of macroinvertebrate species across the study area would not occur under alternative A.

Amphibians. The analysis of impacts on amphibians is focused on two species: the long-toed salamander and the Northwestern salamander. These two species are sensitive to fish predation and generally not found together in the same lakes in the North Cascades Complex. Since there are limited data available on salamander presence, abundance, and viability in all 91 lakes in the study area, impacts were assessed based on several predictive factors taken from the literature and research. These factors, in various combinations, tend to correlate with certain observed levels of impacts. The factors include fish density, total Kjeldahl nitrogen (TKN), and lake connectivity, as well as availability of suitable habitat.

Table 31 summarizes the impact thresholds for amphibians, based on the predictive factors. Appendix G provides more detail concerning the factors used in the thresholds. Table G-3 in appendix G provides an assessment of impacts on amphibians by lake for each alternative. Generally, impacts would be expected to be high if TKN levels are high, the Index of Connectivity (IOC) is low, and densities of fish in a lake are high. If, for instance, densities of fish are low or the IOC is particularly high for a lake or if TKN levels are low, the impact would be reduced. In some cases where data for one or more of the predictive factors were missing, a conservative estimate was made. Impacts would be less than predicted, and future monitoring (see appendix F) would be used to determine the impacts and take appropriate management actions in the future.

The Index of Connectivity (IOC) is based on the number of known salamander populations within 3.75 miles of a study area lake and the number of potential long-toed salamander breeding ponds within 0.4 mile.

Based on the thresholds developed, in 7 of the 91 lakes in the study area, impacts on long-toed salamanders would be expected to be adverse, major, and long term. These lakes have high densities of reproducing trout with various combinations of low TKN levels and/or low IOC values, all of which are associated with declines in amphibian numbers. As research has shown, long-toed salamanders are at risk of extirpation in low-productivity lakes (TKN values less than 0.045 mg/L) with high-density fish populations (greater than 100 fish per acre) (Liss et al. 1995, 1999, 2002). Also, a low connectivity with other lakes indicates a reduced possibility of recovery of local populations that may be extirpated, since there are few nearby subpopulations to serve as sources for recolonization of the affected lake. Six of the 7 lakes do not have recorded values for TKN and have been assigned a major impact based on the possibility of low TKN values. If subsequent research shows that TKN values in these lakes are high, the level of impacts would be reduced.

In 11 of the 91 lakes, impacts on amphibians would be expected to be adverse, moderate, and long term, based on the thresholds established. Three of these lakes have high densities of reproducing trout and are within the range of Northwestern salamanders. Research has shown that the Northwestern salamander can coexist with high densities of reproducing trout and still remain viable, although at measurably reduced larval densities (Larson and Hoffman 2002; Hoffman et al. 2003). This is likely due to the large size of the older larvae and adults in this species, as well as changes in their behavior in the presence of fish (they become active only at night and stay close to the shore or other escape cover) (Brokes 1999; Hoffman et al. 2003; Larson and Hoffman 2002). Eight of the 11 lakes are within the range of long-toed salamanders, and all have various combinations of either high IOC values or high TKN values combined with high densities of reproducing trout, which contribute to moderate impacts.

In 15 of the 91 lakes, impacts on amphibians would be expected to be adverse, minor, and long term. Three of the 14 lakes are within the range of Northwestern salamanders but have low densities of trout. Research has shown that the Northwestern salamander can coexist with low densities of reproducing trout with slightly reduced larval densities (Hoffman et al. 2003). This is likely due to the large size of the older larvae and adults in this species, as well as changes in their behavior in the presence of fish (Brokes 1999; Hoffman et al. 2003; Larson and Hoffman 2002). Twelve of the 15 lakes are within the range of long-toed salamanders but have low densities of trout, causing the impacts to be minor. Three of these 12 lakes do not have recorded values for TKN and have been assigned a minor impact based on the possibility of high TKN values. If subsequent research shows that TKN values in these lakes are low, the level of impacts would be reduced.

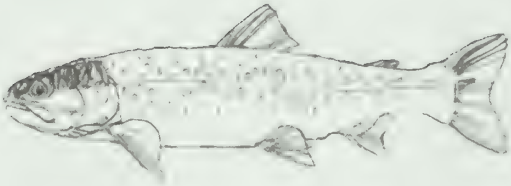
In 58 of the 91 lakes, long-term adverse impacts on amphibians would be negligible. Twenty-nine of the 58 lakes are fishless and, therefore, have no impacts on salamanders from stocked fish. Of the remaining 29 lakes, 20 have fish but do not have salamanders because they are either outside the distribution of salamanders in the North Cascades Complex or do not have suitable aquatic or terrestrial habitat for long-toed or Northwestern salamanders. Eight lakes are within the range of long-toed salamanders, but contain low densities of stocked trout with various combinations of TKN values and IOC values that indicate that long-toed salamanders should be able to survive and do well, given the lower fish densities, available nitrogen, and lake connectivity. One lake has a low density of trout, but does not have a recorded TKN value, so it has been assigned a negligible impact because it has an IOC of 0.8.

Impairment of amphibian species across the study area would not occur under alternative A.

Native Fish. Impacts on native fish populations were assessed using the professional knowledge of both NPS and WDFW staff involved in preparing this plan/EIS, who have direct experience and/or data regarding the status of native fish in many study area drainages. Where data were lacking, impacts were assessed based on predictive factors that include the particular species of trout reproducing or stocked in a lake and the type of native fish present in the downstream watershed. Also, specific knowledge of the extent of colonization and hybridization, as provided by WDFW biologists familiar with study area streams, was used to determine if major impacts existed.

Table 31 summarizes the predictive factors for native fish used in the assessment, while appendix G provides a more detailed discussion of the impact thresholds. Table G-5 in appendix G provides an assessment of impacts on native fish by lake for each alternative.

In one of the 91 lakes (McAlester), long-term adverse impacts on downstream native fish communities from reproducing populations of fish would be considered major. This lake has a surface outlet connecting to its downstream drainage and contains a high density of reproducing hybrid rainbow/cutthroat trout not native to the downstream watershed. Also, it is known that both colonization and hybridization have occurred with downstream native westslope cutthroat trout (WDFW, M. Downen, pers. comm., 2004). Research indicates that native fish communities in watersheds below mountain lakes can be adversely affected if salmonids stocked into mountain lakes colonize downstream outlets and hybridization occurs. Other impacts can occur through competition for resources (competition for food or for spawning habitat) and predation on juvenile native fish.



The WDFW refers to bull trout and Dolly Varden char collectively as "native char" because the two species are impossible to reliably distinguish between without genetic analysis.

In 9 lakes, adverse impacts on downstream native fish would be considered moderate. In these lakes, there are reproducing brook trout in a west-side lake and reproducing rainbow trout in an east-side lake. These predictive factors indicate a potential for major impacts, but neither colonization nor hybridization has occurred in the outlet streams; therefore, impacts are considered moderate (WDFW, M. Downen, pers. comm., 2004). Introductions of brook trout or closely related taxa of nonnative trout (*Oncorhynchus* sp./spp.) can have drastic consequences on native salmonids in watersheds throughout western North America (Behnke 1992; Gresswell and Varley 1988; Stoltz and Schnell 1991; Trotter 1987). Brook trout are especially aggressive and can traverse high-gradient stream reaches to colonize tributaries. They can also compete with native trout for available resources in headwater streams and tributaries (Adams et al. 2001). It has been documented that stocked rainbow trout replace native populations of westslope cutthroat trout throughout its native range, either through competition or hybridization (Behnke 1992). Westslope cutthroat trout are not native to west-side stream basins and have the potential to compete with native trout and coho salmon for resources, prey on juvenile native char, and hybridize with coastal rainbow and cutthroat trout (WDFW, M. Downen pers. comm., 2004). Future monitoring would help to validate this assessment.

In 26 of the 91 lakes, impacts on downstream native fish communities from stocked fish are expected to be adverse, minor, and long term. Five of these lakes are west-side lakes that contain populations of nonnative strains of reproducing rainbow trout (WDFW, M. Downen, pers. comm., 2004), which may adversely affect downstream populations of native char and trout. Seven of these lakes are east-side lakes that contain stocked populations of Mt. Whitney rainbow trout. This strain has a very limited potential for downstream dispersal and, on the east side of the Cascade Crest, rainbow trout do occur as a native species. Therefore, any downstream dispersal would have limited potential for hybridization. The remainder of the 26 lakes have reproducing nonnative westslope cutthroat in west-side lakes. This presents a minor impact because westslope cutthroat trout reproduce later than native salmonids, and this restricts the potential for hybridization.

In 55 of the 91 lakes, adverse impacts on downstream native fish communities from stocked fish would be considered negligible. In 26 of these lakes, either no surface outlet exists, or the trout that are present are native to the watershed in which the lake is located. For example, if westslope cutthroat trout were stocked in an east-side lake or coastal cutthroat trout were stocked in a west-side lake, it

is very unlikely that the stocked trout would establish reproducing populations in outlet streams or contribute to the hybridization of native populations of coastal rainbow and cutthroat trout. Neither the Mt. Whitney nor the California golden strains are likely to disperse downstream, or if that would occur, it would likely be self-limiting due to ineffective competition (WDFW, B. Pfeifer, pers. comm., 2002; WDFW, M. Downen, pers. comm., 2004). The remaining 29 lakes are currently fishless, and any residual adverse impacts from past stocking would be considered negligible.

Impairment of native fish species across the study area would not occur under alternative A.

Impacts of Current Lake Treatment Methods on Aquatic Organisms

No lake treatments occur under alternative A; therefore, there would be no impacts on aquatic organisms from lake treatment methods.

Cumulative Impacts

No projects are proposed or in planning stages that would change the road access to any unit of the North Cascades Complex, and no new major trails or trailheads are being considered. Flooding in recent years has limited some access to certain lakes, and this would result in a short-term reduction of activity around certain lakes, including fishing. No new resorts or major upgrades of existing facilities are known. Overall, visitor use is expected to follow about the same patterns that it has for several years, resulting in the same level of fishing pressure on most lakes and connected streams. This use of the lakes and surrounding drainages would contribute negligible to minor adverse impacts on the plankton, macroinvertebrates, amphibians, and native fish that may inhabit the shallow riparian areas that visitors use to cross and enter the waters for fishing. This causes very limited compaction of shorelines and sedimentation of the waters where these animals breed, feed, and hide from other predators, with resultant negligible to minor impacts.

Mountain lake fisheries on National Forest System lands that surround the North Cascades Complex are also managed by the WDFW. The department's management approach (described in WDFW [2001]) is expected to be similar in the foreseeable future to what is currently being done. No lakes or streams inside the North Cascades Complex boundaries are directly downstream from an outside lake with reproducing fish, so no impacts would be expected in the study area from outside fishery management actions.

There would be continued, localized, and sporadic effects on native fish and other aquatic organisms from logging and dams and reservoir construction that have occurred and continue to occur outside the North Cascades Complex, including adjacent watersheds. These actions cause nonpoint pollution (primarily runoff of disturbed or exposed soils) that would adversely affect water quality by decreasing oxygen levels, increasing temperatures, and creating sedimentation that can cover spawning habitat. Impact levels on aquatic organisms in the North Cascades Complex or in downstream drainages would vary, depending on the location of the projects and the species present. Pre-construction surveys and mitigation measures are usually required to minimize effects on native species, especially any protected species, so most impacts on aquatic organisms in the study area from these actions would be negligible to minor. Even with mitigation, various levels of adverse impacts on species have occurred and may continue.

Other sources of impacts continue to occur that may affect the health and viability of native aquatic organisms. In some lakes in the North Cascades Complex, persistent organic pollutants (POP) and methyl-mercury have been found that appear to result from airborne pollutants being deposited on snow and washed into lakes. There may be an additional source of airborne pollution from the Darrington Power Plant, which, if approved, would operate about 20 miles southwest of the North Cascades Complex. Plant operation could potentially increase regional acid deposition, thereby increasing lake acidity and metal availability. Some of these pollutants might bioaccumulate to higher concentrations in the top predators in a system, such as salamanders in a lake, to the point where the pollutants would cause species to be less viable. If that occurred, then the cumulative impacts of pollutants and other impacts, perhaps from fish, might eliminate that predator species from certain lakes or even cause a more general decline in the population. Future monitoring may help to determine if bioaccumulation of persistent organic pollutants or methyl-mercury were occurring in high mountain lakes. Also, there is some concern that diseases or water mold may be spread by stocking affected fish; however, there is no evidence that this has occurred, and the water mold, *Saprolegnia*, is already present in the natural environment (WDFW 2001). In addition, hatcheries used by the WDFW are very cautious about eliminating the risk of disease or mold in their stocks, so the threat of impacts from mold or disease is considered negligible.

Overall, the cumulative impacts associated with other actions in the area, added to the impacts predicted under alternative A, would result in short- and long-term minor to potentially major adverse impacts on plankton, macroinvertebrates, amphibians, and/or certain species of native fish in individual lakes in the study area but with overall minor to moderate impacts for the region.

Conclusion

Table 32 summarizes the direct impacts expected, by numbers of lakes, for plankton, macroinvertebrates, amphibians, and native fish.

Aquatic organisms (including plankton, macroinvertebrates, and amphibians) would continue to experience long-term negligible to minor adverse impacts from fish predation and competition in lakes stocked with low densities of nonreproducing fish.

In lakes with high densities of reproducing fish, certain plankton and macroinvertebrates would continue to experience long-term moderate to major adverse impacts from intensive predation and competition. Long-term minor to moderate, adverse impacts on amphibians would continue in lakes with reproducing populations of fish, limited refugia, relatively high nutrient (for example, high total Kjeldahl nitrogen) availability, and limited lake connectivity to other water bodies with suitable amphibian habitat.

Long-term moderate to major adverse impacts from hybridization between native and nonnative fish would continue to persist.

Short- and long-term adverse cumulative impacts on aquatic organisms would vary widely depending upon trends in aquatic ecosystem stressors such as air pollution, development in surrounding watersheds, and climate change. Overall, the cumulative impacts associated with other actions in the area, added to the impacts predicted under alternative A, would result in short- and long-term minor to potentially major adverse impacts on plankton, macroinvertebrates, and amphibians, and/or certain species of native fish in individual lakes in the study area but with overall minor to moderate adverse impacts for the region.

Impairment of aquatic organisms across the study area would not occur under alternative A.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

The emphasis of this alternative would be to eliminate or reduce numbers of reproducing fish from lakes in the study area. Restocking of nonreproducing fish would be allowed only where biological resources would be protected. Based on best available science, some lakes would be restocked with nonreproducing fish at low densities once reproducing fish have been removed. Lakes where information needed to make these decisions is missing would not be stocked until that information becomes available, as discussed in the monitoring program and associated adaptive management approach described in appendix F. This extensive monitoring program would be implemented in order to adjust management in the future to avoid unacceptable effects on native biota from fish presence.

Alternative B

- 29 lakes would have fish
- 49 lakes would be fishless
- 13 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

Impacts of Proposed Fish Stocking on Aquatic Organisms

Plankton. Under alternative B, adverse impacts in 14 lakes would gradually be reduced over time from major or moderate levels to minor levels, since all lakes that previously had very high or high densities of fish would have the densities reduced or fish eliminated, and fish density is a key factor affecting plankton in high mountain lakes. Overall, 29 of the 91 lakes would be expected to experience minor long-term adverse impacts as low-density fish populations are created or retained through various methods. Long-term direct and indirect impacts on the plankton community would continue to occur for the foreseeable future. Direct impacts would include predation and competition for prey; indirect impacts would include changes in nutrient cycling and food web dynamics.

In 62 other lakes, impacts on plankton would be considered negligible. In 13 of these lakes, fish would be removed or no longer stocked, and the lakes would be evaluated to determine if stocking at low densities would be resumed. Over the long term, adverse impacts on plankton would be reduced to negligible levels, which would increase to minor levels if fish stocking were resumed. In 20 of the 62 lakes, removal or discontinued stocking of fish would be permanent and occur over time. Adverse impacts would be gradually reduced to negligible levels, with the expected recovery of plankton populations and community structure to conditions comparable to those in historically stocked but currently fishless lakes. Beneficial effects would result from the removal of fish and the long-term recovery of the plankton community. The remaining 29 lakes with negligible impacts are those that were historically stocked but are currently fishless and would remain fishless. Plankton abundance and community structure in these lakes would primarily be influenced by biogeographical evolutionary processes.

Impairment of plankton species across the study area would not occur under alternative B.

Macroinvertebrates. Under alternative B, high-density fish populations would gradually be reduced or eliminated, which would eventually eliminate all major and moderate adverse impacts on macroinvertebrates throughout the North Cascades Complex. Low-density fish populations would be retained in 29 of the 91 lakes by either stocking with nonreproducing fish, reducing the density of existing fish populations, or supplementing low-density reproducing fish by stocking some nonreproducing fish. In these 29 lakes, long-term direct and indirect impacts on the macroinvertebrate community would continue to occur for the foreseeable future. Direct and indirect impacts would be the same as described for alternative A and would include predation and competition for prey and changes in nutrient cycling and food web dynamics. These impacts would be adverse, minor, and long term.

In 62 of the 91 lakes, adverse impacts on macroinvertebrates would be considered negligible. Thirteen of these lakes would be further evaluated prior to determining management actions. Existing low-density reproducing or stocked populations would be removed, and the response of native biota in these lakes, including macroinvertebrates, would be monitored. Low-density nonreproducing fish would be stocked only if monitoring results indicate it is appropriate. Macroinvertebrate populations and community structure would be expected to recover to levels comparable to those in currently fishless but otherwise similar lakes. Initial direct and indirect impacts would be negligible, although stocking of low-density nonreproducing fish in these lakes would result in minor impacts. In 20 of the 62 lakes, removal or discontinued stocking of fish would occur over time, and impacts would gradually be reduced to negligible levels with the expected recovery of macroinvertebrate populations and community structure to conditions comparable to those in historically stocked but currently fishless lakes. Beneficial effects would result from fish removal and by providing for the long-term recovery of macroinvertebrate populations and community structure.

The remaining 29 lakes are those that were historically stocked but are currently fishless and would remain fishless. Macroinvertebrate abundance and community structure in these lakes would primarily be influenced by biogeographical and evolutionary processes, with negligible residual adverse impacts.

Impairment of macroinvertebrate species across the study area would not occur under alternative B.

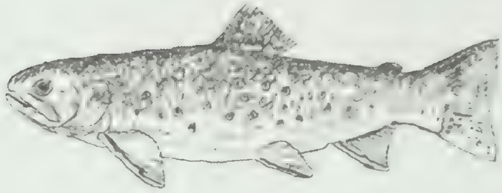
Amphibians. Under alternative B, the eventual reduction of fish density would gradually eliminate major and moderate impacts on amphibians over time. In 9 of the 91 lakes, impacts on amphibians would be expected to be minor. Three of the 9 lakes are within the range of Northwestern salamanders, but have low densities of trout. Six of the lakes are within the range of long-toed salamanders but have low densities of trout with low IOC (Index of Connectivity) values, causing the impacts to be on a minor level. Two of these 6 lakes do not have recorded values for TKN and have been assigned a minor impact based on the possibility of high TKN values. If subsequent research shows that TKN values in these lakes are low, the level of impacts would be reduced. In very general terms, impacts would be high if TKN levels are high, the IOC is low, and densities of fish in a lake are high. If, for instance, densities of fish are low or IOC is particularly high for a lake or if TKN level are low, the impact would be reduced. For a more detailed discussion of how impact levels were derived, see appendix G.

In 82 of the 91 lakes, impacts on amphibians would be negligible. Twenty-nine lakes would remain fishless, with negligible residual adverse impacts. Of the 53 remaining lakes, 20 are either outside the distribution of salamanders or do not have suitable aquatic or terrestrial habitat for long-toed or Northwestern salamanders. The remaining 33 lakes are within either the range of long-toed salamanders or the range of Northwestern salamanders. Adverse impacts on salamanders in these 33 lakes would gradually be reduced to negligible levels as the lakes either become fishless or have low densities of trout with high IOC values. For those 13 lakes that would undergo further evaluation, impacts would increase if stocking were resumed in the future.

Impairment of amphibian species across the study area would not occur under alternative B.

Native Fish. The extent of impacts on downstream native fish communities under alternative B would be reduced compared to alternative A, with the eventual elimination of the one major and nine moderate impacts identified in alternative A.

In 7 lakes, long-term impacts would be minor because high-density populations of nonnative brook and rainbow trout would be eliminated from high mountain lakes in the study area. However, there would still be reproducing rainbow trout or cutthroat trout not native to the basin in a west-side lake (e.g., westslope cutthroat in a west-side lake) or, an east-side Mt. Whitney rainbow trout in an east-side lake. The presence of these nonnative fish would result in some competition, predation, and possible interbreeding with native species, but because of the greatly reduced densities that would remain in the lakes, it is unlikely that a large number of fish would escape to downstream waters. In the case of the Mt. Whitney rainbow, there are no native rainbows present on the east side, and therefore, there is some concern about the potential for hybridization.



Brook trout, a nonnative fish, are especially aggressive and can compete with native trout for available resources.

In 84 lakes, long-term adverse impacts on native fish would be negligible. In 55 of these lakes, high densities of fish would be removed and either not restocked or restricted to low-density nonreproducing trout. Impacts on downstream native fish communities from reproducing populations of fish would gradually be reduced to negligible levels because nonreproducing fish would be the only fish stocked in any of the lakes after removal of the present populations. In other lakes with negligible impacts, any reproducing trout remaining would be incapable of establishing reproducing populations in outlet streams or hybridizing with native populations of fish, similar to alternative A, or there is no connecting outlet to downstream basins. Finally, 29 of the 84 lakes are fishless and would remain fishless, with residual negligible impacts on downstream native fish. Overall, the reduction in density and/or elimination of fish would yield a long-term beneficial effect to downstream native fish.

Impairment of native fish species across the study area would not occur under alternative B.

Impacts of Proposed Lake Treatment Methods on Aquatic Organisms

The lake treatment methods that are proposed in this plan/EIS are discussed in detail in the "Alternatives" chapter.

The method proposed for use in each lake was selected based on the type of fish population present and the physical characteristics of the lake environment. The proposed methods have a range of potential adverse impacts on aquatic organisms, depending on the methods and aquatic resource category considered.

Natural Methods. Under alternative B, natural methods would be used at 12 lakes. The use of natural methods means discontinuing all stocking and allowing the remaining nonreproducing fish to gradually die out and/or be eliminated through fishing. This approach is effective only in lakes without extensive natural reproduction. Because natural removal methods involve no direct actions within each lake, very limited human presence, and no mechanized transport (such as helicopters), these methods would result in effectively no or negligible adverse impacts on any group of aquatic organisms.

Mechanical Methods. Mechanical removal methods involve two different approaches: (1) the use of gillnets, fyke nets, or hook and line to remove fish, possibly combined with electrofishing and/or trapping; and (2) physical exclusion of fish from their spawning habitat. In the case of gillnetting, helicopters would be used to transport equipment to the site. The use of nets and traps is proposed for 8 lakes. This method has effectively no potential for direct or indirect impacts on plankton; therefore, impacts on plankton from this removal method are considered negligible. There is some risk of impacts on macroinvertebrate species from trampling or other sources of mechanical injury, but the extent of these potential impacts is considered to be minor. Amphibians face some risk of direct impacts from trampling, or possibly from electroshocks if they are in the immediate vicinity of the apparatus while it is being operated. Amphibian adults, which may not survive prolonged submersion, may be captured in traps or entangled in nets; however, the number of individuals potentially impacted would be small, and nets and traps would be inspected daily to reduce or eliminate nontarget organism mortality. Therefore, impacts on amphibian populations would be short term and minor. There is effectively no potential for impacts on native fish in downstream drainages; therefore, the extent of impacts on native fish is considered negligible. All impacts resulting from use of nets or traps would be of short-term duration, and no impacts relating to noise from the short-term presence of a helicopter over the site would be expected to affect any aquatic species.

The spawning habitat exclusion treatment method involves blocking access to the tributary spawning areas of mountain lakes by "cobbling over" gravel beds in the inlet or outlet tributaries to the lake, which creates a barrier to the spawning habitat. This method is proposed for only one lake: Wilcox/Lillie, Upper. Because these actions would not take place in the subject lake, and would not result in any appreciable changes in lake characteristics, this approach poses essentially no risk of adverse direct impacts on plankton and native fish. Physical modification of tributary areas presents some risk of direct impacts on macroinvertebrates and amphibians in these areas, but impacts would be minor and short term.

Benthos: Organisms that live in or on the bottom in aquatic habitats (the benthic zone). "Macrobenthos" includes all invertebrates that are found in the benthos; they are typically larger than one millimeter.

Chemical Method. The chemical method is proposed for use in 19 lakes under alternative B. This involves the use of the piscicide antimycin to kill fish populations (refer to the "Alternatives" chapter for details about this chemical and its mode of action). The chemical method would be proposed for large lakes with reproducing fish populations where mechanical removal methods would not be practical. Antimycin was selected for use over other piscicides because it is effective at relatively low concentrations, degrades rapidly, does not repel target fish, and has been shown to have only relatively minor and/or short-term impacts on nontarget organisms. Effects of antimycin on plankton and invertebrates vary depending on concentration levels and on the type of organism, as evidenced by numerous studies. Rabe and Wissmar (1969) observed a reduction in zooplankton abundance following antimycin application in an alpine lake environment, but this effect was short term. Controlled applications of antimycin in experimental ponds (generally applied at typical concentrations for fish control) resulted in no observable effects on any species of macrobenthos (Houf and Campbell 1977). However, antimycin treatments at higher concentrations have been observed to result in macroinvertebrate mortality in stream environments, with these effects being of short-term duration (Jacobi and Degan 1977; Morrison 1987). Furthermore, a recent report written by Finlayson et. al. (2001) states that the toxicity of antimycin to aquatic invertebrates has been found to be similar to that of fish at concentrations comparable to those that would be used in lakes in the North Cascades Complex study area. Some taxa, such as water fleas, copepods, amphipods, stoneflies, and caddisflies, are reportedly more sensitive to antimycin; while stoneflies, dragonflies, annelid worms, and water bugs appear to more resistant (Schnick 1974). Field tests of antimycin effects have shown no observable impacts on various amphibian species at typical fish-control treatment levels.

Antimycin has little potential for adverse impacts on downstream fish populations if application is effectively controlled. It degrades rapidly in turbulent water, losing its effectiveness after an elevational drop of 200 to 300 feet (Tiffan and Bergersen 1996). The distance and elevation drop separating high mountain lakes from native fish populations would create an effective separation from the treated environment. To ensure complete protection of downstream fish populations, antimycin applications would be neutralized at the lake outlet by adding small amounts of potassium permanganate, which is an oxidizer with no adverse impacts on water quality or nontarget organisms (Morrison 1987).

Based on the available literature, the potential impacts of chemical fish treatment on plankton, macroinvertebrates, and amphibian populations and communities in 19 lakes would be direct, short term, and minor. Potential direct and indirect impacts on native fish would be negligible.

Antimycin use would result in moderate, direct, short-term impacts (of one to several years' duration) to sensitive plankton and macroinvertebrates, since it would be expected to cause an initial die-off and/or reduction in density to sensitive species in the treatment area. However, sensitive taxa would be expected to recover (in terms of their previous abundance and diversity) within one to several years after treatment. Over the long term, taxa would indirectly benefit from the removal of fish predation. Impacts on amphibian populations and communities would be direct, short-term, and minor. Potential direct and indirect impacts on downstream native fish would be negligible.

Cumulative Impacts

Cumulative impacts under alternative B would be similar to those described under alternative A, but slightly reduced due to the eventual elimination of impacts in those lakes and connected watersheds where nonnative fish would be eliminated, resulting in 49 fishless lakes (compared to 29 fishless lakes under alternative A).

No lakes or streams inside the North Cascades Complex boundaries are directly downstream from an outside lake with reproducing fish, so no impacts would be expected in the study area from outside fishery management actions.

Overall, the impacts associated with other actions in the region, added to the residual impacts predicted under alternative B, would have minor to moderate adverse impacts on all groups of aquatic organisms on both an individual lake and regional basis.

Conclusion

Table 32 summarizes the direct impacts expected, by numbers of lakes, for plankton, macroinvertebrates, amphibians, and native fish.

Aquatic organisms (including plankton, macroinvertebrates, and amphibians) would continue to experience long-term negligible to minor adverse impacts from fish predation and competition in lakes that would continue to be stocked with low densities of nonreproducing fish. These impacts would decline further in the future as stocking is curtailed or eliminated in lakes based on adaptive management decisions pertaining to stocking.

Removal of reproducing populations of fish from select lakes would eventually result in long-term beneficial effects on aquatic organisms in those lakes; however, removal of reproducing fish populations would take many years. Until fish are removed, minor to major impacts on aquatic organisms would persist as described in alternative A.

Mechanical methods of fish removal (netting, trapping, spawning habitat exclusion) would have short-term negligible to minor adverse impacts on aquatic organisms. Chemical methods of fish removal (application of the piscicide antimycin) would have short-term negligible to moderate adverse impacts on certain aquatic organisms.

Long-term minor to moderate adverse impacts on native fish would continue to be primarily associated with hybridization between native and nonnative fish. The risk of hybridization would decline over the long term as reproducing populations of fish were removed and fewer nonnative fish dispersed downstream from lakes. The risk of hybridization, however, would not be entirely eliminated primarily because reproducing populations of nonnative fish are now present in many drainages throughout the North Cascades Complex.

Compared to alternative A, there would be a long-term beneficial cumulative impact on native aquatic organisms because a minimum of 20 lakes would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would vary widely depending upon trends in aquatic ecosystem stressors such as air pollution, development in surrounding watersheds, and climate change.

Impairment of aquatic organisms across the study area would not occur under alternative B.

Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish)

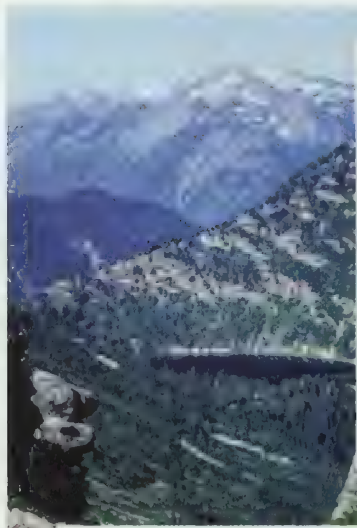
Under alternative C, 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish and 2 lakes would be evaluated for restocking. Eleven other lakes in the national recreation areas would remain fishless or be returned to fishless conditions. The remaining 69 lakes (which are in the national park) would be returned to their natural fishless conditions or would remain fishless.

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter and appendix E.

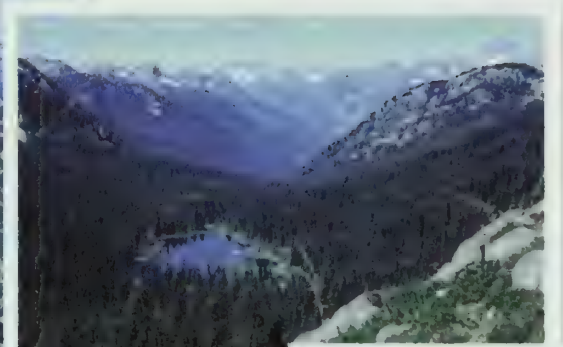
Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

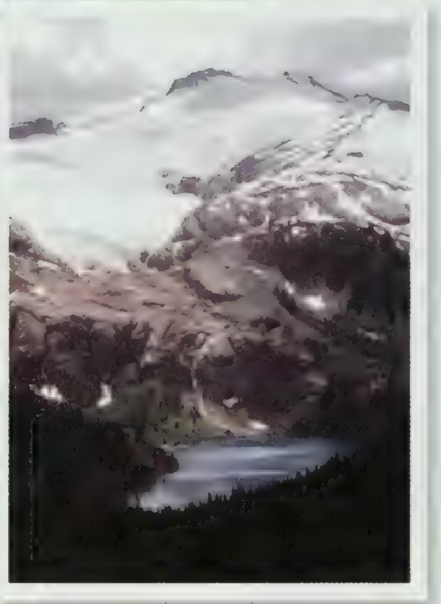
Sourdough Lake

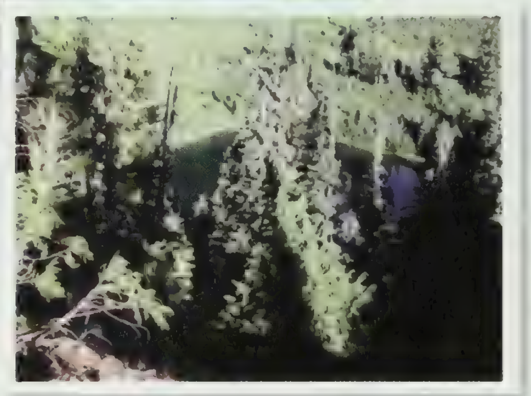


Dagger Lake



Green Lake





Diobsud Lake No. 2, Lower

Battalion Lake

McAlester Lake

Under alternative B, a management action code of "2B" would be applied to the six lakes pictured above, in addition to Blum (Largest/Middle, No. 3) and Dee Dee, Upper.

Impacts of Proposed Fish Stocking on Aquatic Organisms

Plankton. Under alternative C, more lakes would be treated over time to remove fish, so impact levels would gradually be reduced in more lakes in the study area, compared to alternative A. At the completion of all lake treatments, minor impacts would occur in 9 lakes, where low-density fish populations would be retained by either replacing high densities of fish with lower densities, or continuing to stock with low densities of nonreproducing fish. In these lakes, adverse impacts on the plankton community would be long term and minor. Direct and indirect impacts would be of the same type as described under alternative A and would include predation and competition for prey and changes in nutrient cycling and food web dynamics.

Two of the 91 lakes would be further evaluated prior to determining management actions. In these lakes, existing low-density reproducing or stocked populations would be removed, and the response of native biota, including plankton, would be monitored. Low-density nonreproducing fish would be stocked only if results of monitoring indicate it would be appropriate. Plankton populations and community structure would be expected to recover to levels comparable to those in currently fishless but otherwise similar lakes. Initial direct and indirect impacts would be negligible, although restocking the lakes with low-density nonreproducing fish would be expected to result in minor impacts.

In 51 of the 91 lakes, existing low-density reproducing or stocked populations of introduced fish would be removed. Plankton populations and community structure would be expected to recover to levels comparable to those in historically stocked but currently fishless lakes that are otherwise similar. Minor impacts would be reduced to negligible over time. Residual long-term adverse impacts would be considered negligible, and long-term beneficial effects would result.

Under alternative C, the 29 historically stocked but currently fishless lakes would remain fishless. Plankton abundance and community structure in these lakes would primarily be influenced by biogeographical and evolutionary processes, as described for alternative A, with residual adverse negligible impacts.

Impairment of plankton species across the study area would not occur under alternative C.

Macroinvertebrates. Under alternative C, more lakes would be treated over time to remove fish, so impact levels would gradually be reduced in more lakes in the study area. Minor impacts would occur in 9 lakes, where low-density fish populations would be retained by either replacing high densities of fish with lower densities, or continuing to stock with low densities of nonreproducing fish. In these lakes, the impacts on macroinvertebrates would be minor and long term. Direct and indirect impacts would be the same as those described under alternative A (those impacts are predation and competition for prey and changes in nutrient cycling and food web dynamics).

In two other lakes, further evaluation would be completed prior to determining management actions. In these lakes, the existing low-density reproducing or

stocked populations would be removed, and the response of native biota, including macroinvertebrates, would be monitored. Low-density stocked populations would be reintroduced only if monitoring results indicate it is appropriate. Macroinvertebrate populations and community structure would be expected to recover to levels comparable to those in currently fishless but otherwise similar lakes. Direct and indirect impacts would be negligible. Restocking of low-density nonreproducing fish in these lakes would be expected to result in minor impacts.

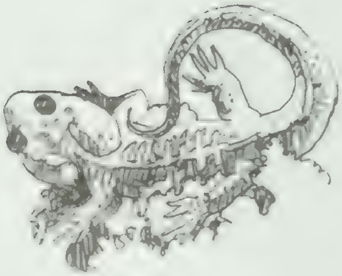
In 51 lakes, removal or discontinuation of fish stocking would allow for the expected gradual recovery of macroinvertebrate populations and community structure to conditions comparable to those in historically stocked but currently fishless lakes. Minor impacts would gradually be reduced to long-term negligible impact levels, and long-term beneficial effects would result.

Under alternative C, 29 historically stocked but currently fishless lakes would remain fishless. Macroinvertebrate abundance and community structure in these lakes would primarily be influenced by biogeographical or evolutionary processes, as described for alternative A, with negligible residual adverse impacts.

Impairment of macroinvertebrate species across the study area would not occur under alternative C.

Amphibians. Under alternative C, no lakes would experience major or moderate impacts on amphibians, and more lakes would have impacts gradually reduced from minor to negligible levels because more lakes would either become fishless or be reduced to low fish densities.

In five lakes, adverse impacts on amphibians are predicted to be minor. Three of these lakes are within the range of Northwestern salamanders but have low densities of trout. Two of these lakes are within the range of long-toed salamanders but have low densities of trout with low IOC (Index of Connectivity) values, which indicate minor impact levels.



Northwestern salamander

In 86 of the 91 lakes, impacts on amphibians would be considered negligible. Twenty-nine lakes would continue to remain fishless, with negligible residual adverse impacts. Of the 57 remaining lakes, 20 are either outside the range of salamanders or do not have suitable aquatic or terrestrial habitat for long-toed or Northwestern salamanders. Thirty-four of these lakes are within the range of long-toed salamanders, and 3 are within the range of the Northwestern salamander. Impacts on salamanders in these 37 lakes would gradually be reduced to negligible levels because the lakes have either become fishless or have low densities of trout with high IOC values. For a more detailed discussion of how impact levels were derived, see appendix G.

Impairment of amphibian species across the study area would not occur under alternative C.

Native Fish. Under alternative C, the potential for adverse impacts on downstream native fish would be substantially reduced over time, compared to

alternative A, with no major or moderate adverse impacts. Only one lake, Unnamed MR-16-01, would continue to have minor impacts on downstream native fish. In Unnamed MR-16-01, a low-density population of reproducing cutthroat trout would continue to remain in a west-side lake, which would pose a minor threat to downstream native fish through competition. The reproductive status of the trout would need to be evaluated to determine if a minor impact actually exists.

In 90 lakes, long-term impacts on native fish would be negligible. In some of these lakes, fish would be removed and either not restocked or restocked with low densities of nonreproducing trout. Impacts on downstream native fish from stocked fish would eventually become negligible because nonreproducing fish would be the only fish stocked in any of the lakes after removal of the present populations. In other lakes with negligible impacts, any reproducing trout remaining would be incapable of establishing reproducing populations in outlet streams or hybridizing with native fish, similar to alternative A, or there is no connection to downstream basins. The 29 currently fishless lakes would remain fishless, with residual negligible adverse impacts. Overall, the widespread reduction in fish densities and/or elimination of fish under alternative C would be a long-term benefit to downstream native fish.

Impairment of native fish species across the study area would not occur under alternative C.

Impacts of Proposed Lake Treatment Methods on Aquatic Organisms

Under alternative C, the types of impacts associated with the various lake treatment methods would be the same as described for alternative B; however, the number of lakes affected by those treatments would vary, and more lakes would experience impacts (albeit minor and short term) from chemical and mechanical treatments to remove fish.

Natural Methods. Under alternative C, 21 lakes would be subject to natural fish removal methods, which means stocking would be discontinued; this is 9 more lakes than alternative B. There would be few, if any, impacts on any aquatic organisms from this type of treatment, which involves natural die-out and removal by fishing, so impacts would remain about the same – negligible and short term.

Mechanical Methods. There would be 10 lakes slated for mechanical treatment, an increase of only 2 lakes over alternative B. Impacts on macroinvertebrates and amphibians would be short term and minor, and impacts on native fish and plankton would be negligible for all aspects of this treatment. Overall, impacts would be about the same as for alternative B.

Chemical Method. For chemical treatment, the number of lakes treated would increase to 25. Impacts on sensitive plankton and macroinvertebrates from the use of antimycin would be moderate, direct, and short term due to the expected die-off of certain sensitive species in the vicinity of the treatment. Impacts on sensitive taxa would be expected to return to their previous abundance and

diversity within one to several years after treatment. Over the long term, taxa would indirectly benefit from the removal of fish predation. Impacts on amphibian populations and communities would be direct, short term, and minor. Potential direct and indirect impacts on downstream native fish would be negligible. Six more lakes would be treated in this manner compared to alternative B, but the overall increase in impact intensity would be minor because adverse impacts from the use of antimycin are so limited.

Cumulative Impacts

Cumulative impacts under alternative C would be similar to those described under alternative A but reduced due to the elimination of impacts in those lakes and connected watersheds where high-density populations of fish would be eliminated, resulting in up to 80 fishless lakes (compared to 29 fishless lakes under alternative A). There would be reduced fishing pressure on the lakes and connected streams in the North Cascades Complex. Anglers would be displaced to surrounding lakes, and there would be negligible to minor impacts on aquatic organisms from visitors crossing and entering the waters for fishing.

No lakes or streams inside the North Cascades Complex boundaries are directly downstream from an outside lake with reproducing fish, so no impacts would be expected in the study area from outside fishery management actions.

Overall, the impacts associated with other actions in the region, added to the residual impacts predicted under alternative C, would have minor to moderate adverse impacts on all groups of aquatic organisms, both at an individual lake and in the region.

Conclusion

Table 32 summarizes the direct impacts expected, by numbers of lakes, for plankton, macroinvertebrates, amphibians, and native fish.

Aquatic organisms (including plankton, macroinvertebrates, and amphibians) would continue to experience long-term negligible to minor adverse impacts from fish predation and competition in national recreation area lakes that would continue to be stocked with low densities of nonreproducing fish. These impacts could decline further in the future as stocking is curtailed or eliminated in lakes based on adaptive management decisions pertaining to stocking.

Removal of reproducing populations of fish from lakes in the national park portion of the North Cascades Complex would eventually result in long-term beneficial effects on aquatic organisms in those lakes where removal proved feasible; however, removal of reproducing fish populations from the entire national park unit and select lakes in the national recreation areas would take many years. Until fish are removed, minor to major impacts on aquatic organisms would persist as described in alternative A.

Mechanical methods of fish removal (netting, trapping, spawning habitat exclusion) would have short-term negligible to minor adverse impacts on aquatic organisms. Chemical methods of fish removal (application of the piscicide antimycin) would have short-term negligible to moderate adverse impacts on certain aquatic organisms.

Long-term minor to moderate adverse impacts on native fish would continue to be associated with hybridization between native and nonnative fish. The risk of hybridization would decline over the long term as reproducing populations of fish are removed and fewer nonnative fish dispersed downstream from lakes. The risk of hybridization, however, would not be entirely eliminated primarily because nonnative fish are now present in many drainages throughout the North Cascades Complex.

Compared to alternative A, there would be a long-term beneficial cumulative impact on populations of native aquatic organisms because a minimum of 51 lakes (all lakes in the national park unit and select national recreation area lakes) would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would vary widely depending upon trends in aquatic ecosystem stressors such as air pollution, development in surrounding watersheds, and climate change.

Impairment of aquatic organisms across the study area would not occur under alternative C.

ALTERNATIVE D: 91 LAKES WOULD BE FISHLESS

Under alternative D, the goal would be to remove fish from all 91 lakes in the study area. All 91 lakes would eventually be unavailable for fishing, with some fish remaining in certain lakes as management actions are implemented over time.

The “Alternatives” chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the “Alternatives” chapter and appendix E.

Impacts of Proposed Fish Stocking on Aquatic Organisms

Plankton. In the 62 fish-bearing lakes where fish populations would be removed or allowed to die out, the plankton community would generally be expected to recover over the years to conditions comparable to those in historically fish-bearing but currently fishless lakes, with resultant negligible impacts. Since lakes would be treated over time, some minor to moderate impacts would continue until all high-density populations of nonnative fish were removed. Upon removal, the phytoplankton community structure that would develop in each lake may be different from what was historically present before fish stocking, but all species would most likely be present, based on studies completed to date (Drake and Naiman 2000).

Research has shown that, in many cases, zooplankton that have been adversely impacted can recover after fish are removed (Parker et al. 2001), and zooplankton

species can be effectively reintroduced to lakes through managed introductions (McNaught et al. 1999; Parker et al. 2001). Therefore, it is expected that most zooplankton species would eventually recover to abundance comparable to historic levels, unless the population has been completely extirpated by predation, and that extirpated species would be reintroduced from adjacent lakes if desired. Using such approaches, the zooplankton community structure would be rehabilitated to levels comparable to those in fishless but otherwise similar lakes. Long-term effects of fish removal would be expected to be beneficial, with larger changes occurring in lakes that currently have high-density fish populations.

Twenty-nine lakes were historically stocked with trout but are currently fishless. Observed plankton community structure and abundance in these lakes is generally comparable to those in similar fishless lakes. Plankton populations in these lakes would be influenced mainly by biogeographical or evolutionary processes. Residual adverse impacts of fish stocking in these lakes would be considered negligible after recovery has occurred. These lakes serve as a benchmark for expected conditions in lakes following a period recovery after fish are removed.

Impairment of plankton species across the study area would not occur under alternative D.

Macroinvertebrates. Removal of fish from 62 lakes would eventually result in the expected recovery of the macroinvertebrate community to levels comparable to those in historically stocked but currently fishless lakes. Macroinvertebrate species in individual lakes that have been extirpated by predation would be expected to recolonize from adjacent areas within several years, depending on species and proximity of other breeding areas. Research indicates that effects on macroinvertebrates are often limited to the segments of the population exposed to fish predation and that, while some population segments may be depressed or even temporarily eliminated, these species usually have a high dispersal potential and recolonize relatively quickly (Bilton et al. 2001; Bohonak and Jenkins 2003). Species would also be reintroduced through management intervention if desired. Residual adverse impacts in all 62 lakes would be negligible and long term, with some minor to possibly major impacts remaining for several years until all lakes with high densities of fish are treated. The eventual removal of fish would result in long-term beneficial effects in all these lakes, with the greater benefits occurring in lakes that currently have higher fish densities.

Twenty-nine lakes were historically stocked with trout but currently have no fish populations. Observed macroinvertebrate community structure and abundance in these lakes is generally comparable to those in similar fishless lakes. Macroinvertebrate populations in these lakes would be influenced mainly by biogeographical or evolutionary processes. Residual adverse impacts of fish stocking in these lakes would be considered negligible after recovery has occurred. These lakes would serve as a benchmark for expected conditions in lakes following a period of recovery after fish are removed.

Impairment of macroinvertebrate species across the study area would not occur under alternative D.

Amphibians. Under alternative D, fish would gradually be removed from 62 lakes, resulting in long-term residual adverse impacts on amphibian communities from fish populations, but at a negligible level. Until all high-density populations are removed, some minor to major impacts would continue. Long-term effects of fish removal would be beneficial. In the absence of fish predation, terrestrial amphibian adults, surviving larvae, or neotenic adults would be expected to re-establish populations in a lake.

Impairment of amphibian species across the study area would not occur under alternative D.

Native Fish. Under alternative D, fish would eventually be removed from 62 lakes (or allowed to disappear through natural mortality or not being restocked), resulting in a reduction of impacts on downstream native fish communities to negligible levels over time. Some minor to moderate adverse impacts may continue for several years as management actions are implemented. The long-term effects of fish removal would be beneficial.

Impairment of native fish species across the study area would not occur under alternative D.

Impacts of Proposed Lake Treatment Methods on Aquatic Organisms

For alternative D, the types of impacts associated with the various lake treatment methods would be the same as described under alternative B; however, the numbers of lakes affected by those treatments would vary, and more lakes would experience impacts (albeit minor and short term) from chemical and mechanical treatments to remove fish.

Natural Methods. Under alternative D, 26 lakes would be subject to natural removal methods where stocking would be discontinued. This is 14 more lakes than alternative B and 5 more than alternative C. However, since there are few, if any, impacts on aquatic organisms from this type of removal, overall impacts would remain about the same – short term and negligible.

Mechanical Methods. There would be 11 lakes slated for mechanical treatment under alternative D, an increase of only 1 lake over alternative C and 3 lakes more than alternative B. Again, with minimal adverse impacts expected, impact levels would remain short term and minor for amphibians and macroinvertebrates and negligible for native fish and plankton.

Chemical Method. The same number of lakes (25) would be chemically treated under alternative D as under alternative C. Impacts on plankton and macroinvertebrates from the use of antimycin would be moderate, direct, and short term due to the expected die-off of certain sensitive species in the vicinity of the treatment. The sensitive taxa would be expected to return to their previous abundance and diversity within one to several years after treatment. Over the long term, taxa would indirectly benefit from the removal of fish predation. Impacts on amphibian populations and communities would be direct, short term,

and minor. Potential direct and indirect impacts on downstream native fish would be negligible.

Cumulative Impacts

Under alternative D, cumulative adverse impacts on all aquatic organisms would be less than that described for alternative A, since all 91 lakes would eventually be fishless, thus eliminating the adverse impacts associated with fish presence. However, cumulative impacts under alternative D would still occur, even with the added beneficial effects of fish removal because there are so many other actions that would adversely affect all the groups of aquatic organisms in the region.

Overall, the impacts associated with other actions in the region, added to the long-term beneficial effects predicted under alternative D, would be expected to result in negligible to minor adverse impacts on plankton, macroinvertebrate, amphibian, and native fish, both at an individual lake and in the region.

Conclusion

Table 32 summarizes the direct impacts expected, by numbers of lakes, for plankton, macroinvertebrates, amphibians, and native fish.

Aquatic organisms (including plankton, macroinvertebrates, and amphibians) would continue to experience long-term negligible to minor adverse impacts from fish predation and competition until stocked populations of fish gradually died out or were removed through treatment. Once these stocked fish are gone, native aquatic communities would eventually revert to predisturbance (that is, prestocking) conditions, and this would result in long-term beneficial impacts on native aquatic organisms.

Removal of reproducing populations of fish from all study area lakes in the North Cascades Complex would eventually result in long-term beneficial effects on aquatic organisms in those lakes where removal proved feasible; however, removal of reproducing fish populations from study area lakes would take many years. Until fish are removed, long-term minor to major adverse impacts on aquatic organisms would persist as described in alternative A.

Mechanical methods of fish removal (netting, trapping, spawning habitat exclusion) would have short-term negligible to minor adverse impacts on certain aquatic organisms. Chemical methods of fish removal (application of the piscicide antimycin) would have short-term negligible to moderate adverse impacts on certain aquatic organisms.

Long-term minor to moderate adverse impacts on native fish would continue to be associated with hybridization between native and nonnative fish. The risk of hybridization would decline over the long term as reproducing populations of fish are eventually removed from study area lakes in the North Cascades Complex. The risk of hybridization, however, would not be entirely eliminated primarily because nonnative fish are now present in many drainages throughout the North Cascades Complex.

Compared to alternative A, there would be a long-term beneficial cumulative impact on populations of native aquatic organisms because all study area lakes in the North Cascades Complex would eventually become fishless. Short- and long-term adverse cumulative impacts on aquatic organisms from threats other than nonnative fish would vary widely depending upon trends in aquatic ecosystem stressors such as air pollution, development in surrounding watersheds, and climate change.

Impairment of aquatic organisms across the study area would not occur under alternative D.

WILDLIFE

Black bears are omnivores that will eat any kind of food (plant or animal), including fish, if the opportunity presents itself.

The wildlife potentially affected by the proposed alternatives include mammals, birds, and reptiles that are either native to lake habitats in the North Cascades Complex or are occurring in high mountain lakes in the North Cascades Complex due to the presence of stocked fish. Amphibians and fish are discussed in the section titled "Aquatic Organisms." Additionally, wildlife inhabiting drainages downstream from lakes in the North Cascades Complex may also be affected by mountain lakes fishery management decisions. Impacts would occur from stocking or fish removal and associated activities under proposed management actions.

This section describes the methods used to analyze impacts on wildlife and results of the analysis. The following section discusses the regulations and policies used to guide NPS decision making, in addition to the assumptions and thresholds used to analyze impacts on wildlife.

GUIDING REGULATIONS AND POLICIES

The *General Management Plan* (NPS 1988b) includes the following management objectives that are relevant to overall natural resources, including wildlife, for the North Cascades Complex:

> Increase knowledge and understanding of the interrelationships of the natural processes, and of methods for implementation of appropriate actions.
>
> Preserve, maintain, or restore, where feasible, the primary natural resources and those ecological relationships and processes.
>
> Manage the natural resources as an integral part of a regional ecosystem.
>
> Provide opportunity for research in as natural a system as possible.

The *Strategic Plan* (NPS 2000a) includes goals for preserving resources in the North Cascades Complex that are consistent with the goals and objectives of this analysis. Mission Goal I.a. states that

> Natural and cultural resources and associated values of the North Cascades National Park Service Complex are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context.

Servicewide NPS regulations and policies, including the NPS *Organic Act of 1916*, *NPS Management Policies* (NPS 2001a), and NPS Reference Manual 77, *Natural Resource Management*, also direct national parks to provide for the protection of park resources. The *Organic Act* directs national parks to conserve wildlife unimpaired for future generations and is interpreted to mean that native animal life are to be protected and perpetuated as part of a park unit's natural ecosystem. Parks rely on natural processes to control populations of native species to the greatest extent possible; otherwise, they are protected from harvest, harassment, or harm by human activities. The *NPS Management Policies* (NPS 2001a) make restoration of native species a high priority. Management goals for wildlife include maintaining components and processes of naturally evolving park ecosystems, including natural abundance, diversity, and ecological integrity of plants and animals (NPS 2001a, 4.1). Policies in the NPS *Natural Resources Management Guidelines* state, "the National Park Service will seek to perpetuate the native animal life as part of the natural ecosystem of parks" and that "native animal populations will be protected against . . . destruction . . . or harm through human actions."

METHODOLOGY AND ASSUMPTIONS

The following discussion describes the methodology used to evaluate the impacts of the proposed alternatives on wildlife in the North Cascades Complex. Analysis methods are qualitative and are based on anecdotal evidence and field observations by NPS staff, reviews of existing data and literature, and best professional judgment. NPS staff provided information on species distribution in the North Cascades Complex.

The analysis presented in this section assumes that the historic and current stocking in mountain lakes has created favorable ecological conditions for piscivorous (fish eating) wildlife that previously were unlikely to inhabit these lakes due to lack of favorable resources. Piscivorous wildlife or other species that eat fish opportunistically are now present at a number of lakes in the North Cascades Complex because they have become accustomed to the presence of fish in previously fishless lakes.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

The geographic area evaluated for impacts on wildlife includes the North Cascades Complex, which is comprised of the north and south units of North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area. More specifically, these impacts were evaluated for wildlife likely to occur in or near the 91 mountain lakes in the North Cascades Complex with a history of fish stocking, or those species that would be disturbed by management activities; for example, aircraft and helicopter noise would disturb wildlife during stocking or lake treatment activities. Impacts on wildlife inhabiting the drainage basins that extend beyond the North Cascades Complex boundaries are also considered because stocking or removing fish that migrate downstream from high mountain lakes may impact wildlife that use those fish as a food resource.

OUTCOMES OF MANAGEMENT ACTIONS

Several of the management actions that would be applied to lakes under each of the action alternatives have potential multiple outcomes, depending on the results of future monitoring and adaptive management decisions made based on these results. Therefore, for the purpose of this plan/EIS, the focus is on the initial outcome of the management actions, with the assumption that the lakes would either have fish or not have fish, based on the initial results of the actions taken. It is recognized that these conditions may change in some of the lakes due to decisions made under the proposed mountain lakes fishery monitoring plan presented in appendix F. If future monitoring indicates that fish presence has caused unacceptable changes to native biota, and as a result, fish are removed or reduced, impacts would also be reduced from what is presented here.

IMPACT CRITERIA AND METHODOLOGY

Potential impacts on wildlife and wildlife habitat were evaluated based on the species present and their association with stocked fish, as well as the effects of stocking or lake treatment methods associated with fish removal. Information on habitat and other existing data were acquired from staff at the North Cascades Complex, the WDFW, U.S. Fish and Wildlife Service, and available literature.

Methods to evaluate impacts on wildlife use alternative A as the baseline condition against which the action alternatives are compared because it represents current management practices. The analysis focuses on effects to wildlife from fish populations in mountain lakes, as well as impacts incurred as a result of management activities and removal of fish at the population and community levels. A population is defined as a group of individuals within a given species that are reproductively isolated from other groups and have geographically defined distributions. Communities are defined as the interacting populations of all species in a resource category. Literature on wildlife responses to noise provided available research to assess potential impacts on species from the use of helicopters or fixed-wing aircraft during lake management or lake treatment activities in the North Cascades Complex.

IMPACT THRESHOLD DEFINITIONS

The following thresholds were used to determine the magnitude of effects on wildlife and wildlife habitat as a result of implementation of any of the alternatives, including stocking and treatment methods:

Negligible. An action would result in no observable or measurable impacts on native wildlife species, their habitats, or the natural processes sustaining them and would be of short duration, localized, and well within natural population fluctuations.

Minor. An action would result in detectable impacts, but they would not be expected to result in substantial population fluctuations and would not be expected to have any measurable long-term effects on native species, their habitats, or the natural processes sustaining them. Occasional responses to disturbance by some individuals would be expected, but without interference to feeding, reproduction, or other factors affecting population levels.

Moderate. An action would result in detectable impacts on native wildlife, their habitats, or the natural processes sustaining them. Key ecosystem processes may experience disruptions that would be outside natural range of fluctuation (but would return to natural conditions). Sufficient habitat would remain functional to maintain viability of native wildlife populations.

Major. An action would result in detectable impacts on native wildlife, their habitats, or the natural processes sustaining them. Key ecosystem processes might be disrupted permanently. Adverse responses to disturbance by some individuals would be expected, with negative impacts on feeding, reproduction, or other factors resulting in a long-term decrease in population numbers and genetic variability.

Impairment. An action would disrupt ecosystem processes resulting in elimination of a species or large population declines, locally and range-wide. In addition, these adverse, major impacts on the North Cascades Complex's resources and values would

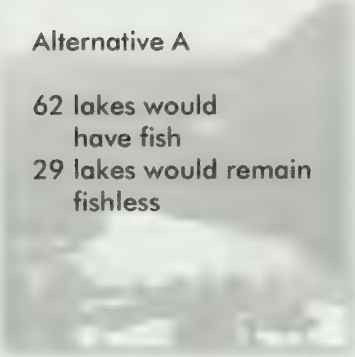
> contribute to deterioration of wildlife resources and values to the extent that the purpose of the North Cascades Complex would not be fulfilled as established in its enabling legislation
>
> affect resources key to the natural or cultural integrity or opportunities for enjoyment in the North Cascades Complex
>
> affect the resource whose conservation is identified as a goal in the *General Management Plan* (NPS 1988b) or other planning documents for the North Cascades Complex

IMPACTS OF THE ALTERNATIVES ON WILDLIFE

This section analyzes impacts for each of the four alternatives. The first section under each alternative addresses impacts that would result from stocking decisions made for each of the 91 lakes. The impacts are related to the numbers of stocked fish that would remain in the subject lakes, as well as disturbance from stocking activities. Next, a section is provided to address impacts related to the various lake treatment methods. Finally, cumulative impacts are discussed, and an overall summary of impacts is presented at the end of each alternative analysis.

Many wildlife species inhabiting the North Cascades Complex that are considered in this plan/EIS are not directly linked to fish or aquatic habitats, but under any of the alternatives, management activities resulting in increased human presence and the noise from fixed-wing aircraft or helicopters have the potential to adversely affect wildlife.

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)



Alternative A

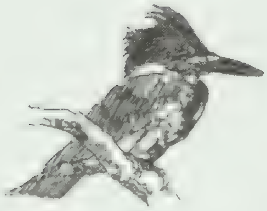
62 lakes would have fish
29 lakes would remain fishless

The current mountain lakes fishery management activities at the North Cascades Complex, which are described in the "Alternatives" chapter, would continue under the no-action alternative.

For detailed information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.

Impacts of Current Fish Stocking on Wildlife

The majority of impacts on wildlife under alternative A would be related to the number of fish stocked and/or density of reproducing fish in the lakes. To a lesser degree, noise and disturbance associated with stocking activities are also considered. As described in the "Alternatives" chapter, current stocking is accomplished by packing fry into lakes or dropping fry from fixed-wing aircraft. Impacts on wildlife from helicopters are only discussed under alternatives B, C, and D because, under those alternatives, helicopters would only be used to apply treatments to remove fish; they are no longer used to stock fish in the North Cascades Complex. Stocking would occur infrequently, anywhere from annually to every 10 years, and would vary from lake to lake. As described in the "Alternatives" chapter, a fly-over occurs once per stocking cycle, and the plane flies over the lake very briefly, typically less than a minute. The preferred stocking method is for one or two people to backpack the fish to the lake. In some cases, backpack stocking requires overnight camping because of the extensive distances. Mitigation measures to prevent impacts from campers around lakes are outlined below and in appendix I.



Fish are a primary food source for bird species such as the belted kingfisher.

In the 62 lakes under alternative A that have been stocked with fish, impacts on wildlife would be negligible to minor. Stocking fish in the North Cascades Complex has altered lake community dynamics over time. Many wildlife species that historically did not inhabit the high mountain lakes have expanded their ranges to include new areas where fish have become abundant. Under alternative A, fish-eating wildlife would continue to use the lakes in the North Cascades Complex that are stocked. Fish are a primary food source for several species that are observed at or regularly inhabit mountain lakes in the North Cascades Complex. These species include river otters and several bird species such as mergansers, belted kingfishers, and ospreys. Ospreys have been seen feeding on fish at several lakes in the North Cascades Complex, although they do not nest at the lakes. For other species, like the garter snake, there may be adverse impacts from fish presence because fish would compete for the same prey (salamanders, insects).

Impacts from stocking activities associated with fixed-wing aircraft and backpackers would be expected to affect the species discussed previously, including species that do not live in or next to the lakes but inhabit nearby woods. Those species are deer, elk, mountain goats, bats, and a variety of raptors and passerine birds. The intensity of noise impacts would decrease with increased distance from the lakes because the intensity of sound decreases with distance (there is generally a 6 decibel reduction in sound level for each doubling of distance from a noise source due to spherical spreading loss), plus the trees provide some buffering capacity. Noise disturbance would occur as aircraft approach and fly over the lakes during stocking. Stocking by fixed-wing aircraft occurs during the summer and fall months when wildlife are active. Noise from aircraft would approach 70 to 80 decibels, compared to estimated typical background levels of 20 to 40 decibels in the North Cascades Complex (see table 33).

Noise at high levels can cause behavioral and physiological reactions in wildlife that vary by species and individuals (Knight and Gutzwiller 1995). Additional factors affecting wildlife response to noise include duration and previous exposure to noise, habitat type, season, activity occurring at time of disturbance, and the existing physical condition of the individual (Radle 2004). Physiological responses in wildlife include an increased heart rate and stress. Behavioral responses vary from mild reactions, such as changes in body position, to severe panic and escape reactions that interrupt normal activities or, in extreme cases, abandonment of normal territories or home ranges. For ungulates such as deer and elk, behavioral reactions seem to be related to a past experience with human and aircraft disturbance. In previous studies on ungulate responses to aircraft overflights in national parks, herd response to aircraft varied from no response to panic and escape (DOI 1988). Birds typically flush from a nest or perch in response to a disturbance but will usually return within a few minutes (NPC 2004).

TABLE 33: SOUND LEVEL COMPARISON CHART*

Decibels	How it Feels	Equivalent Sounds
140–160	Near permanent damage level from short exposure	Large caliber rifles such as .243, 30–06
130–140	Pain to ears	.22 caliber weapon
100	Very loud, conversation stops	Air compressor at 20 feet; garbage trucks and city buses; power lawnmower; diesel truck at 25 feet
90	Intolerable for phone use	Steady flow of freeway traffic; 10 horsepower outboard motor; garbage disposal; helicopter at 1,000 feet (70–90 decibels)
70–80		Fixed-wing aircraft or helicopter flyover; automatic dishwasher or vacuum cleaner (80 decibels)
60	Quiet	Window air conditioner in room; normal conversation
50	Sleep interference	Quiet home in evening
40		Library; frontcountry camping or developed site
30		Soft whisper
20		In a quiet house at midnight; leaves rustling; remote sites (Death Valley, interior wooded areas with backcounty camping)

Note:

* Modified from *Pictured Rocks National Lakeshore Personal Watercraft Use Final Environmental Impact Statement*, 2003; Tetra Tech 1987; U.S. Forest Service 2001.

Most noise disturbances would not be severe enough to cause detectable changes in population size or reproductive success (Knight and Gutzwiller 1995). Aircraft flyovers for stocking would occur from every 1 to 10 years, and the duration of each flyover would be short. Backpackers may trample vegetation while stocking fish at lakeshores; however, this impact is expected to be negligible, and habitat would return to pre-disturbance conditions. Wildlife in or near lakes may experience short-term and temporary disturbances from stocking activities, such as interruption of activity or temporary flushing or fleeing, but this would not change population structure or function. Many wildlife species such as bats, rodents, and forest-dwelling birds would incur only negligible or no impacts under alternative A because stocking would occur far enough away from these species that normal activities would not be disturbed.

In the 29 lakes that were historically stocked but are currently fishless, impacts on wildlife would be negligible. Under alternative A, the 29 lakes would remain fishless.

Impairment of wildlife species across the study area would not occur from current fish stocking under alternative A.

Impacts of Current Lake Treatment Methods on Wildlife

Under alternative A (no action), none of the 91 lakes addressed in this plan/EIS are currently being treated.

Cumulative Impacts

Recreational use of the lakes and surrounding drainages would contribute negligible to minor impacts on the wildlife in the North Cascades Complex. Some of this disturbance to wildlife from backpackers, campers, and non-anglers would be mitigated by natural topography of the landscape and forested areas that provide refuge. Other species that inhabit the more open lands would eventually become accustomed to human presence or move to other areas.

On a landscape scale, the piscivorous wildlife generally benefit from the presence of stocked fish in mountain lakes where resources were previously lacking. Continued presence of fish in North Cascades Complex lakes, coupled with continued presence of fish in lakes on surrounding lands, would tend to make piscivorous wildlife more widespread and increase their populations. Conversely, it is likely that species unable to adapt to stocked fish would, or have already become, locally reduced or eliminated over the past 100 years.

There would be continued, localized, and sporadic effects on wildlife from logging and dams and reservoir construction that has occurred and continues to occur outside the North Cascades Complex, including in connected watersheds. These actions can cause severe habitat loss for many forest-dwelling species such as birds, bats, and rodents. The loss of adjacent habitats places more pressure on the wilderness lands in the North Cascades Complex to provide habitat for wildlife, especially larger-bodied species with broad home ranges.

Other sources of impacts continue to occur that may affect the health and viability of species dependent on aquatic resources. There is concern about persistent organic pollutants and methyl-mercury found in some lakes in the North Cascades Complex, which appear to result from airborne pollutants being deposited on snow and washed into lakes. There is the potential for increased acid rain from emissions related to the development of an additional power plant in the area; emissions would contribute to an increase in lake acidity and metal availability. In some cases, the concentrations of some of these pollutants in the water in preliminary studies appear to be high enough to raise concerns that, in conjunction with other negative influences, organisms at higher trophic levels may be affected. Toxins can be passed from the tissue of one organism to those that feed on it, meaning that a toxin can move up the food chain and biomagnify to higher concentrations in the top predators (such as osprey or river otters) in a lake to the point where pollutants would cause reproductive failure. If that occurred, then the cumulative effects of pollutants coupled with other impacts, perhaps from nonnative fish, might eliminate that predator species from certain lakes or even cause a more general decline in the population.

Overall, the impacts associated with other projects and fishery management actions in the area, plus impacts from potential airborne pollution, added to the impacts predicted under alternative A, would be expected to result in long-term, minor, adverse cumulative impacts on wildlife populations and communities in the region.

Conclusion

The historic and current stocking of fish created suitable conditions for piscivorous wildlife, such as fish-eating ducks, while potentially restricting populations of other species, such as amphibians, that are prey for several wildlife species. Impacts from activities associated with periodic fixed-wing aircraft stocking (noise disturbance) and backpack stocking (human presence and habitat trampling) under alternative A would be short term negligible to minor and adverse on wildlife at or near the lakes. Animals that roost or dwell further away from lakes, such an ungulates, bats, rodents, and many forest-dwelling birds, would incur short-term negligible adverse impacts or no impacts from stocking activities. None of the 91 lakes are currently treated for fish removal under alternative A; therefore, wildlife in or near the lakes would not incur impacts from lake treatments.

The impacts associated with other projects and fishery management actions in the area, plus impacts from potential airborne pollution, added to the impacts predicted under alternative A, would result in long-term minor adverse cumulative impacts on wildlife populations and communities in the region.

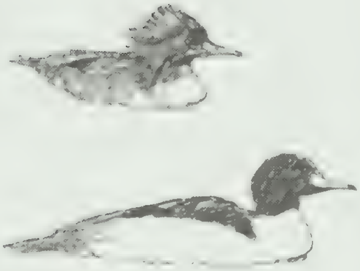
Impairment of wildlife species across the study area would not occur under alternative A.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

The goal of this alternative is to eliminate or reduce reproducing fish from lakes in the study area. Restocking of nonreproducing fish would be allowed only where biological resources would be protected. Based on best available science, some lakes would be restocked with nonreproducing fish at low densities once reproducing fish have been removed. Lakes where critical information is missing would not be stocked until that information becomes available. An extensive monitoring program (see appendix F) would be implemented in order to adjust management in the future to avoid unacceptable effects on native biota from fish presence.

The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

Impacts of Proposed Fish Stocking on Wildlife



Common mergansers have been observed on Coon Lake and are frequently seen along the Stehekin and Skagit rivers (female-top sketch, male-lower sketch).

Under alternative B, impacts of fish stocking on wildlife, including impacts related to the noise and disturbance associated with periodic stocking activity, would be similar to alternative A. Up to 49 lakes would eventually be fishless, compared to 29 under alternative A, and all other lakes would have low densities of fish or be evaluated prior to restocking or fish removal. Removing high densities of fish and/or eliminating fish would result in minor impacts on piscivorous wildlife. Several lakes with high fish densities would be treated to remove all fish. Piscivorous species inhabiting these lakes, such as mergansers or otters, would be displaced to other lakes in search of food if a lake is returned to a fishless state. Species that only occasionally feed on fish if available, such as black bears, would incur negligible impacts under alternative B; however, the consumption of fish by wildlife in the North Cascades Complex is not a natural occurrence because fish are not native to the high mountain lakes. Fish stocking in the North Cascades Complex has created a reliance on lake resources for piscivorous wildlife that now inhabit the area and would be adversely impacted by fish removal.

Impacts on wildlife would be negligible in the 29 lakes that are currently fishless and would not be stocked under alternative B.

Impairment of wildlife species across the study area would not occur from fish stocking under alternative B.

Impacts of Proposed Lake Treatment Methods on Wildlife

The treatment methods proposed for each lake were selected based on the type of fish population present (reproducing vs. nonreproducing), and physical

characteristics of the lake, such as depth and surface area. Each proposed method described below may or may not impact wildlife in the North Cascades Complex.

Natural Methods. Under alternative B, 12 previously stocked lakes would be treated using natural methods. This method is only effective in lakes without extensive natural fish reproduction. Natural removal methods involve no direct actions in each lake, very limited human presence, and no mechanized transport (such as helicopters); therefore, impacts of natural trout removal would be negligible on wildlife.

Mechanical Methods. Under alternative B, up to 8 lakes are being considered for mechanical treatment. For gillnetting, helicopters would transport equipment and lower it to the site, and a team would set nets by hand using float tubes. If traps are used, they would also be set by hand, generally near lake inlets and outlets. The method of gillnetting may unintentionally ensnare nontarget animals such as beavers, river otters, mergansers, ospreys, and salamanders, and traps would also capture small nontarget animals. Standard mitigation would require ground crews to check nets and traps frequently and release any ensnared animals. Although the impacts on individuals, family units, or localized populations of any associated loss would be serious, populations of these animals in the North Cascades Complex would only experience minor impacts.

Electrofishing would be used in lakes where a more thorough removal of all fish is required. Electrofishing would not adversely affect any terrestrial wildlife, and any waterfowl or larger aquatic mammals would avoid the areas being treated. If a backpack generator is needed, minor short-term impacts would result from motor noise, which may cause animals to temporarily flee or avoid the area being treated.

To conduct gillnetting, crews would be required to camp at a lake for several days. Temporary displacement of sensitive wildlife may occur during extended periods of continuous human presence; however, animals are expected to return to areas after a disturbance is removed.

Helicopters used for lake treatment have the potential to stress wildlife, depending on the species and individual response. Helicopters hovering overhead are known to generate noise levels of about 70 to 90 decibels, compared to background levels of 20 to 40 decibels (refer to table 33). Mountain goats are particularly stressed by helicopters and exhibit severe fright and escape responses in the presence of a helicopter (NPS 1994). Other species, such as raptors, may temporarily flush from a nest or perch in the presence of a helicopter but would return after take-off. Helicopters hover over a lake for only a short period of time before landing, and the presence of trees may provide a sight and sound barrier for wildlife in nearby forests. Impacts on wildlife on or near the lakeshore, especially waterfowl and mammals such as otters that nest or den along the shoreline, would be minor, short term, and very infrequent. Impacts would be negligible for those animals occurring farther away from the lakes, such as bear, deer, elk, and many raptors and songbirds.

Bioaccumulation: The accumulation of a harmful substance such as a heavy metal or an organochlorine in a biological organism, especially one that forms part of the food chain.

Chemical Method. Up to 18 lakes under alternative B would be chemically treated to remove fish using the piscicide, antimycin. The chemical method

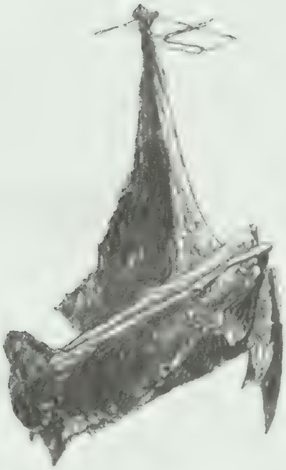
would be used in large lakes with reproducing fish populations where mechanical removal methods would not be practical. Antimycin is very specific in its action; when applied at recommended dosages, it affects fish but is unlikely to affect waterfowl or mammals (Schnick 1974). Also, antimycin is used in such slight quantities that residues are extremely small, and it has not been shown to bioaccumulate (Schnick 1974).

Impacts of fish removal using the chemical antimycin would be negligible to minor. The use of small motorized boats to apply antimycin would cause short-term noise disturbances to waterfowl on the lake or other species (such as beavers or otters) around the immediate lake shore; however, these disturbances would be short term and negligible for those species.

Cumulative Impacts

Cumulative impacts on wildlife under alternative B would be very similar to those described for alternative A, with some additional effects on piscivorous wildlife that would be displaced from lakes where fish are removed.

Overall, the impacts associated with other projects and fishery management actions in the area, plus potential impacts from possible airborne pollution, added to the residual adverse and long-term beneficial effects predicted under alternative B, would be expected to result in long-term minor adverse cumulative impacts on wildlife populations and communities in the region.



Noise disturbances during aircraft stocking would affect some wildlife species that inhabit nearby woods, such as this hanging bat.

Conclusion

The historic and current stocking of fish created suitable conditions for piscivorous wildlife, such as fish-eating ducks, while potentially restricting populations of other species, such as amphibians, that are prey for several wildlife species. Removal of fish would result in the loss of a food source for fish-dependent species, requiring them to disperse to other areas in search of resources; because of this, piscivorous wildlife would incur long-term negligible to minor adverse impacts when lakes are returned to fishless conditions. Stocking activities would decrease, and wildlife at or near the lakes would incur short-term negligible to minor adverse impacts from periodic fixed-wing aircraft stocking (noise disturbance) and backpack stocking (human presence and habitat trampling) that would continue under alternative B but to a lesser degree than under alternative A. Stocking activities would have short-term negligible adverse impacts or no impacts on animals, such as ungulates, bats, rodents, and many forest-dwelling birds, that roost or dwell further away from the lakes. Mechanical and chemical treatment methods used to remove fish under alternative B would result in short-term negligible to minor adverse impacts on wildlife, with short-term disturbance to birds and mammals that inhabit the lake and lakeshore from the noise of human presence and helicopters used to transport equipment for mechanical treatment.

The impacts associated with other projects and fishery management actions in the area, plus impacts from potential airborne pollution, added to the residual adverse and long-term beneficial effects predicted under alternative B, would be expected to result in long-term minor adverse cumulative impacts on wildlife populations and communities in the region.

Impairment of wildlife species across the study area would not occur under alternative B.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

The goal of this alternative is to eliminate all fish in lakes in the national park and reduce or eliminate reproducing fish in the Lake Chelan and Ross Lake National Recreation Areas, but still allow for some sport fishing in these two areas.

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter and appendix E.

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

Impacts of Proposed Fish Stocking on Wildlife

The types of impacts on wildlife from fish stocking would be similar to those described for alternative A; however, there would be 80 lakes that would be fishless compared to 29 lakes under alternative A, with reductions in fish densities in the national recreation area lakes. Lakes with high densities of fish would be treated or evaluated, then treated to remove the fish. Loss of fish resources in these lakes would result in minor to possibly moderate impacts on piscivorous wildlife. Piscivorous species, such as mergansers or otters, would move to other lakes in search of food if a lake is returned to a fishless state. Some wildlife, such as black bears, that feed on fish opportunistically would incur negligible impacts under alternative C because the availability of fish would be less. The consumption of fish by wildlife is not a natural occurrence because fish are not native to the high mountain lakes in the North Cascades Complex, and fish stocking has created a reliance on lake resources for piscivorous wildlife that now inhabit the area and would be adversely impacted by fish removal.

Under alternative C, 29 historically stocked, but currently fishless lakes, would remain fishless. Impacts on wildlife would be negligible in the 29 lakes that would remain fishless.

Impairment of wildlife species across the study area would not occur from fish stocking under alternative C.

Impacts of Proposed Lake Treatment Methods on Wildlife

Under alternative C, the types of impacts associated with the various lake treatment methods would be the same as described for alternative B; however, the number of lakes affected by those treatments would increase, with more wildlife incurring short-term minor impacts from chemical or mechanical treatments to remove fish.

Natural Methods. Under alternative C, 21 previously stocked lakes would be treated using natural methods (lakes would not be restocked, and fish would die out from fishing pressure and natural mortality). Because natural removal methods involve no direct actions in each lake, very limited human presence, and no mechanized transport (such as helicopters), impacts of natural trout removal would be negligible on wildlife.

Mechanical Methods. Under alternative C, up to 10 lakes are being considered for mechanical treatment, an increase of 2 lakes over the number proposed for mechanical treatment under alternative B. Impacts relating to the presence of ground crews and activities such as electrofishing, helicopter use, and netting, would be the same as described for alternative B but would occur at slightly more lakes. Although the impacts on individuals, family units, or localized populations of any associated loss would be serious, populations of these animals in the North Cascades Complex would only experience minor impacts. Minor short-term impacts on some species, such as waterfowl and amphibians, would result from the presence of ground crews and helicopter use.

Chemical Method. There would be 25 lakes treated with the piscicide, antimycin, under alternative C, an increase of 7 lakes over the number that would be chemically treated under alternative B. Impacts on nontarget wildlife would be negligible to minor, as described under alternative B. Noise-related impacts from helicopter and small-boat use during chemical treatment would be short term and minor, but would occur at more lakes over time.

Cumulative Impacts

Cumulative impacts under alternative C would be similar to those described under alternative A, but with additional impacts on piscivorous wildlife that have become dependent on fish in the stocked lakes.

Overall, the impacts associated with other projects and fishery management actions in the area, plus potential impacts from increased airborne pollution, added to the impacts predicted under alternative C, would be expected to result in long-term minor adverse cumulative impacts on wildlife populations and communities in the region.

Conclusion

The historic and current stocking of fish created suitable conditions for piscivorous wildlife, such as fish-eating ducks, while potentially restricting populations of other species, such as amphibians, that are prey for several wildlife species. Removal of fish would result in the loss of a food source for fish-dependent species, requiring them to disperse to other areas in search of resources; because of this, piscivorous wildlife would incur long-term negligible to minor adverse impacts when lakes are returned to fishless conditions. Stocking activities would substantially decrease, and wildlife at or near the lakes would incur short-term negligible to minor adverse impacts from periodic fixed-wing aircraft stocking (noise disturbance) and backpack stocking (human presence and habitat trampling) that would continue under alternative C but to a much lesser degree than under alternatives A and B. Stocking activities would have short-term negligible adverse impacts or no impacts on animals, such as ungulates, bats, rodents, and many forest-dwelling birds, that roost or dwell further away from the lakes. Mechanical and chemical treatment methods used to remove fish under alternative C would result in short-term negligible to minor adverse impacts on wildlife, with short-term disturbance to birds and mammals that inhabit the lake and lakeshore from the noise of human presence and helicopters used to transport equipment for mechanical treatment.

The impacts associated with other projects and fishery management actions in the area, plus impacts from potential airborne pollution, added to the residual adverse and long-term beneficial effects predicted under alternative C, would be expected to result in long-term minor adverse cumulative impacts on wildlife populations and communities in the region.

Impairment of wildlife species across the study area would not occur under alternative C.

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

Sport-fishing opportunities in most of the study area lakes would generally be eliminated within a period of 5 years. Self-sustaining (reproducing) populations of fish would be gradually removed over time—the rate of removal would depend on resource (funding and personnel) availability and differences among fish removal methods. Complete removal of self-sustaining populations of fish in some of the larger, deeper lakes might not be feasible (9 lakes potentially fall into this category—refer to table 7 in the "Alternatives" chapter). These lakes would continue to provide sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved. The phase out of nonnative fish would allow for the protection of biological resources in and around the lakes.

Alternative D

91 lakes would
be fishless

The "Alternatives" chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the "Alternatives" chapter and appendix E.

Impacts of Proposed Fish Stocking on Wildlife

Under alternative D, the 29 lakes that are currently fishless would remain fishless, and fish stocking would be gradually phased out. Nine lakes would be evaluated for the feasibility of fish removal; if complete removal of fish were not possible, then density would be reduced. The remaining 62 lakes would be treated to remove fish over time. Loss of fish resources in the lakes that would become fishless would result in minor to possibly moderate impacts on piscivorous wildlife. Piscivorous species, such as loons, mergansers, or otters, would have to find alternative areas of suitable habitat outside the North

Cascades Complex or would die out; however, piscivorous wildlife inhabiting high mountain lakes are not naturally occurring in the North Cascades Complex, and removal of fish would eventually return the habitat to its condition prior to human manipulation. Some wildlife, such as black bears, that feed on fish opportunistically would incur negligible impacts under alternative D because the availability of fish would be less.

Impairment of wildlife species across the study area would not occur from fish stocking under alternative D because stocking would no longer occur.

Impacts of Proposed Lake Treatment Methods on Wildlife

Under alternative D, the types of impacts associated with the various lake treatment methods would be the same as described for alternative B; however, the number of lakes affected by those treatments would increase, with more wildlife incurring short-term minor impacts from chemical and mechanical treatments.

Natural Methods. Under alternative D, 26 lakes currently stocked under alternative A would not be restocked, and fish would die out from fishing pressure and natural mortality. Because natural removal methods involve no direct actions within each lake, very limited human presence, and no mechanized transport (using helicopters) of equipment, impacts of natural trout removal would be negligible on wildlife.

Mechanical Methods. Under alternative D, a total of 11 lakes are being considered for mechanical treatment, an increase of 1 lake over alternative C, and 3 lakes more than alternative B. Impacts relating to the presence of ground crews, electrofishing, helicopters use, and netting would be the about the same as described for alternatives B and C. Although the impacts on species' individuals, family units, or localized populations of any associated loss would be serious, populations of these animals in the North Cascades Complex would only experience minor impacts. Minor short-term impacts on some species, such as waterfowl and amphibians, would result from the presence of ground crews and helicopter use.

Chemical Method. There would be 25 lakes chemically treated to remove fish using the piscicide, antimycin, the same as alternative C, but an increase of 7 lakes over the number of lakes that would be chemically treated under alternative B. Impacts on nontarget wildlife would be negligible, as described under alternative B. Noise-related impacts from the helicopter and small boat used during lake treatment would be short term and minor but would occur at 25 lakes over time.

Cumulative Impacts

Cumulative impacts under alternative D would be similar to those described under alternative A, but with additional impacts on piscivorous wildlife that have become dependent on fish in the stocked lakes.

Overall, the impacts associated with other projects and fishery management actions in the area, plus possible impacts from potential airborne pollution, added to the impacts predicted under alternative D, would be expected to result in minor adverse cumulative impacts on wildlife populations and communities in the region.

Conclusion

Alternative D would have long-term minor to moderate adverse impacts on fish-eating wildlife in lakes that would become fishless. Removal of fish would result in the loss of habitat for fish-eating species, requiring them to relocate to other areas (potentially outside the North Cascades Complex) in search of resources, which would result in local population decreases for those species, returning the area to pre-stocked conditions. Under alternative D, stocking activities would be eliminated, a slight benefit to wildlife that have been disturbed by the noise and human disturbance associated with stocking activities. Mechanical and chemical treatment methods used to remove fish under alternative D would result in short-term negligible to minor adverse impacts on wildlife, with short-term disturbance to birds and mammals that inhabit the lake and lakeshore from the noise of human presence and helicopters used to transport equipment for mechanical treatment.

The impacts associated with other projects and fishery management actions in the area, plus impacts from potential airborne pollution, added to the residual adverse and long-term beneficial effects predicted under alternative D, would be expected to result in long-term minor adverse cumulative impacts on wildlife populations and communities in the region.

Impairment of wildlife species across the study area would not occur under alternative D.

SPECIAL STATUS SPECIES

GUIDING REGULATIONS AND POLICIES

Special status species of plants and wildlife are included in this section. The *Endangered Species Act* (16 USC 1531 et seq.) mandates that all federal agencies consider the potential effects of their actions on threatened and endangered species and species of special concern. If the NPS determines that an action may adversely affect a federally listed species, consultation with the U.S. Fish and Wildlife Service is required to ensure that the action would not jeopardize the species' continued existence or result in the destruction or adverse modification of critical habitat.

Informal consultation was initiated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (now NOAA Fisheries) during the internal scoping period for this project. A list of species that are known to occur or may occur in the North Cascades Complex was requested. The U.S. Fish and Wildlife Service sent a list of federally listed species, by county occurrence; this list is included in appendix C. For the purpose of this analysis, only those species known to occur in the North Cascades Complex, and that would experience some level of impacts as a result of fishery management actions, are addressed in this section.

This plan/EIS has been submitted to the U.S. Fish and Wildlife Service and NOAA Fisheries for review. If these two entities and other federal agencies agree that no adverse impacts on listed species are likely to occur, no further consultation would be required. If further consultation is needed, this plan/EIS is intended to meet the requirements of a biological assessment.

If actions associated with any fishery management alternative are likely to adversely affect one or more of the federally listed threatened or endangered species identified at the North Cascades Complex, formal consultation would be initiated with the U.S. Fish and Wildlife Service, and a biological assessment would be prepared to document the potential effects to listed species. From the date that formal consultation is initiated, the U.S. Fish and Wildlife Service or NOAA Fisheries has 90 days to consult with the NPS and 45 days to prepare a biological opinion based on the biological assessment and other scientific sources. In the biological opinion, the biological assessment would state whether the proposed fishery management actions would likely jeopardize the continued existence of the listed species or result in the destruction or adverse modification of critical habitat. Such an opinion would most likely be the same as a determination of impairment. To ensure that a species would not be jeopardized by mountain lakes fishery management activities, the NPS would confer with the U.S. Fish and Wildlife Service or NOAA Fisheries to identify recommendations for reducing adverse impacts and would integrate those into the preferred alternative for fishery management in the North Cascades Complex.

NPS Management Policies (NPS 2001a) state that the potential effects of agency actions will also be considered on state or locally listed species. The NPS is required to control access to critical habitat of such species and to perpetuate the natural distribution and abundance of these species and the ecosystems upon which they depend.

METHODOLOGY AND ASSUMPTIONS FOR SPECIAL STATUS WILDLIFE SPECIES

This section describes the methodology used to evaluate the impacts of the proposed alternatives on state and federally listed wildlife and plant species. State and federally listed species were identified through discussions with staff from the North Cascades Complex and informal consultation with the U.S. Fish and Wildlife Service, NOAA Fisheries, and the WDFW (see appendix C). The primary steps in assessing impacts on listed species were to determine

which species inhabit areas likely to be affected by fishery management actions described in the alternatives

current and future distribution of fishery management actions

potential areas of impact as a result of implementation of any of the alternatives, including downstream areas

The information contained in this analysis was obtained through best professional judgment of NPS staff from the North Cascades Complex and experts in fishery management, the U.S. Fish and Wildlife Service, WDFW, and available literature.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

The geographic area evaluated for impacts on special status species includes the 91 lakes in the North Cascades Complex (the study area) that have a history of fish presences as a result of documented or undocumented fish stocking. The North Cascades Complex is comprised of the north and south units of North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area. For fish populations potentially affected by downstream colonization, impacts in downstream drainage basins that extend beyond the boundaries of North Cascades Complex are also considered. These basins include the Chilliwack River (Fraser River Basin), Lake Chelan Basin (including the Stehekin River and its tributaries), and the Skagit River and several of its tributaries.

OUTCOMES OF THE MANAGEMENT ACTIONS

Several of the management actions that would be applied to lakes under each of the action alternatives have potential multiple outcomes, depending on the results of future monitoring and adaptive management decisions. Therefore, for the purpose of this plan/EIS, the focus is on the initial outcome of the management actions and the assumption that the lakes either would have fish or would not, based on the initial results of the actions taken. It is recognized, however, that

these conditions may change in some of the lakes due to decisions made under the proposed monitoring program and adaptive management approach described in the section titled "Adaptive Management" in the "Alternatives" chapter. If future monitoring indicates that fish presence has caused unacceptable changes to native biota, and as a result fish are removed or reduced, impacts may also be reduced from the levels presented in this "Special Status Species" section.

IMPACT CRITERIA AND METHODOLOGY

Impacts on special status species include any activity that would be considered a "take" or cause harm to a species as defined under the *Endangered Species Act*, including harassment. A determination of the potential effects to listed species is treated very conservatively in order to provide maximum protection. Stocking fish in waters that were previously fishless can provide a certain species, such as a piscivorous species, with the opportunity to expand its range into areas previously unsuitable due to lack of food resources. While fish stocking has acknowledged benefits, it can also have negative effects through the introduction of nonnative species, which can alter dynamics of a community, with the resulting loss of ecological integrity.

Potential impacts on special status species or their habitat were evaluated based on species presence, a species' association with stocked fish, and the effects of stocking or lake treatment methods associated with fish removal. Also, where local surveys of fish distribution and abundance were available, existing data and professional knowledge were used to further assess the potential for impacts.

The methods to evaluate impacts on special status species used alternative A as the baseline condition against which the action alternatives were compared because it represents current management. The analysis focused on the effects to special status species from stocked fish in mountain lakes, as well as impacts from other management activities. Literature on wildlife responses to noise provided available research to assess potential impacts on listed species known to occur in the North Cascades Complex.

IMPACT THRESHOLD DEFINITIONS FOR FEDERALLY LISTED SPECIAL STATUS WILDLIFE SPECIES

The following thresholds were used to determine the magnitude of effects on federally listed special status species and their associated habitat that would result from implementation of any of the alternatives, including fish stocking and lake treatment methods to remove fish. Since impacts on native fish were already analyzed in detail in the "Aquatic Organisms" section in this chapter, the assessment of whether an effect on listed native fish would be likely was based on an examination of the same predictive factors and professional knowledge used in the analysis of aquatic organisms. The background information used for the analysis of impacts on native fish can be found in appendix G.

No effect. When a proposed action would not affect a listed species or designated critical habitat.

May affect / not likely to adversely affect. Effects on special status species are discountable (i.e., extremely unlikely to occur and not able to be meaningfully measured, detected, or evaluated) or are completely beneficial.

May affect / likely to adversely affect. When an adverse impact to a listed species may occur as a direct or indirect result of proposed actions and the effect is not discountable or beneficial.

Is likely to jeopardize proposed species / adversely modify proposed critical habitat (impairment). The appropriate conclusion when the NPS or the U.S. Fish and Wildlife Service identifies situations in which the proposal would jeopardize the continued existence of a proposed species or adversely modify critical habitat to a species within or outside the North Cascades Complex boundaries.

State Listed and Special Status Wildlife Species

The assessment of impacts on wildlife species listed by the state of Washington (but not at the federal level) used the same thresholds developed for the assessment of impacts on wildlife, in general; these are repeated below.

Negligible. An action would result in no observable or measurable impacts on native wildlife species, their habitats, or the natural processes sustaining them and would be of short duration, localized, and well within natural population fluctuations.

Minor. An action would result in detectable impacts, but they would not be expected to result in substantial population fluctuations and would not be expected to have any measurable long-term effects on native species, their habitats, or the natural processes sustaining them. Occasional responses to disturbance by some individuals would be expected, but without interference to feeding, reproduction, or other factors affecting population levels.

Moderate. An action would result in detectable impacts on native wildlife, their habitats, or the natural processes sustaining them. Key ecosystem processes may experience disruptions that would be outside the natural range of fluctuation (but would return to natural conditions). Sufficient habitat would remain functional to maintain viability of native wildlife populations.

Major. An action would result in detectable impacts on native wildlife, their habitats, or the natural processes sustaining them. Key ecosystem processes might be disrupted permanently. Adverse responses to disturbance by some individuals would be expected, with negative impacts on feeding, reproduction, or other factors resulting in a long-term decrease in population numbers and genetic variability.

Impairment. The action would contribute substantially to the deterioration of special status wildlife species in the North Cascades Complex to the extent that they would no longer function as a natural system. In addition, some of these adverse major impacts on the North Cascades Complex's resources and values would

> contribute to deterioration of special status wildlife resources and values to the extent that the purpose of the North Cascades Complex would not be fulfilled as established in its enabling legislation
>
> affect resources key to the natural or cultural integrity or opportunities for enjoyment in the North Cascades Complex
>
> affect the resource whose conservation is identified as a goal in the *General Management Plan* (NPS 1988b) or other planning documents for the North Cascades Complex

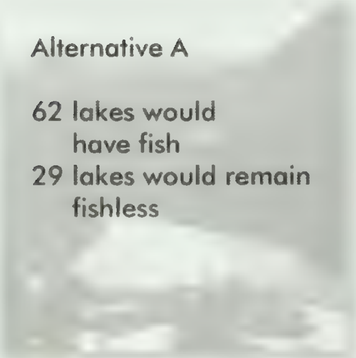
IMPACTS OF THE ALTERNATIVES ON SPECIAL STATUS WILDLIFE SPECIES

This section analyzes impacts on federally listed and state-listed species for each of the four alternatives. Cumulative impacts are discussed, and an overall summary of impacts is presented at the end of each alternative analysis.

Some special status species that inhabit the North Cascades Complex are considered in this plan/EIS that are not directly linked to fish or aquatic habitats, such as the Canada lynx and grizzly bear. These species are included because, under any of the alternatives, management activities would adversely affect wildlife through an increased human presence and noise from fixed-wing aircraft and helicopters associated with lake management activities.

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A (no action) would continue existing practices in the 91 lakes slated for management consideration in the study area. Of these 91, 62 lakes contain fish today. These 62 lakes are a subset of the study area's 91 lakes that were naturally fishless but have a history of fish stocking or fish presence. The remaining 29 lakes are currently fishless and are not actively managed for fish. These management activities would continue under the no-action alternative.



Alternative A

62 lakes would have fish
29 lakes would remain fishless

The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.

Impacts of Current Fish Stocking on Special Status Wildlife Species

For impact assessment purposes, the 11 species listed below are grouped together because the only impacts to these species would be from incidental short-term noise effects from stocking activities (airplane noise or human and vehicle access while approaching a lake). In addition, the 11 species either do not depend solely on lake resources or only eat fish opportunistically.

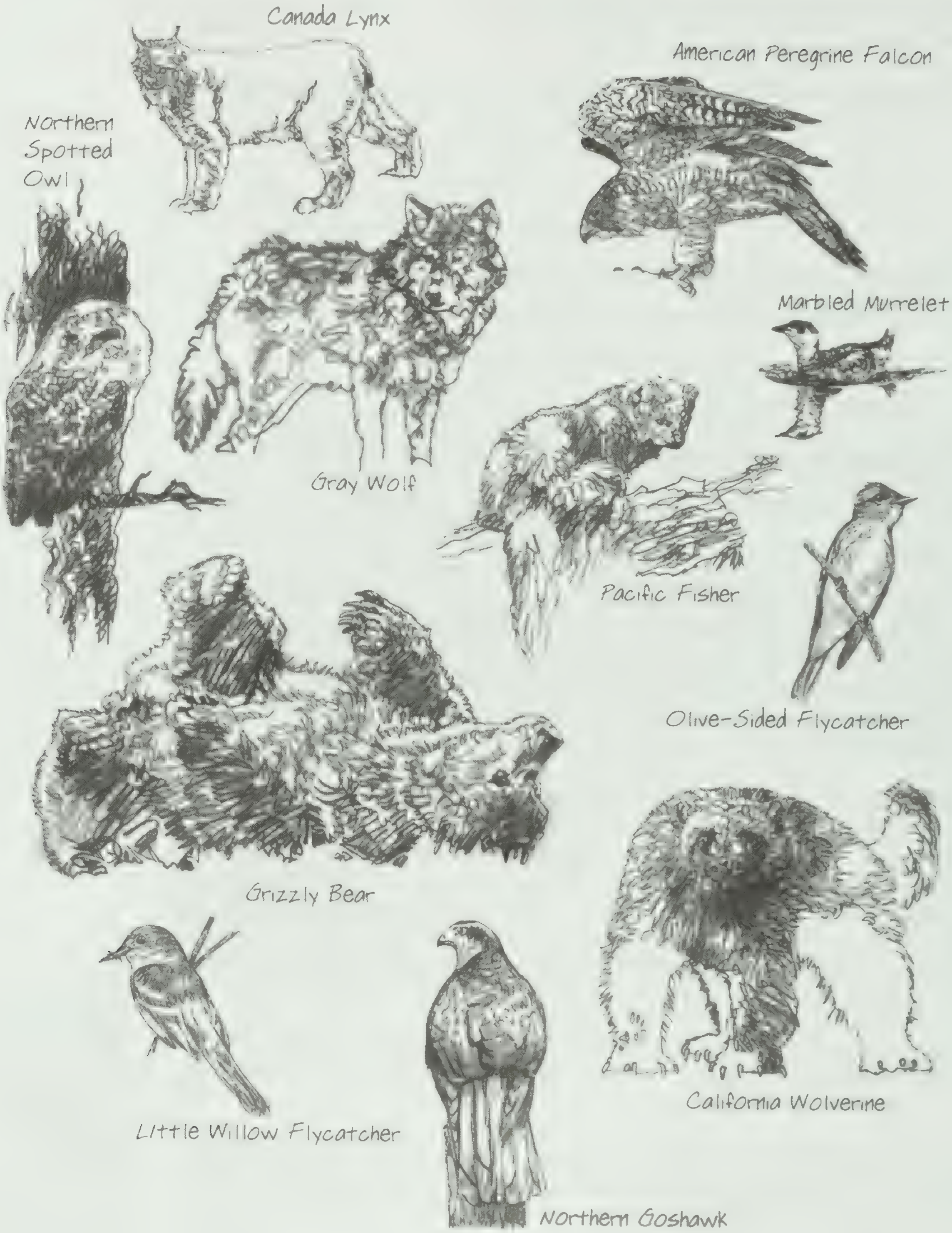
American Peregrine Falcon	federal species of concern, state endangered
California Wolverine	federal species of concern, state candidate
Canada Lynx	federal threatened, state threatened
Gray Wolf	federal endangered, state endangered
Grizzly Bear	federal threatened, state endangered
Pacific Fisher	federal species of concern, state endangered
Marbled Murrelet	federal threatened, state threatened
Little Willow Flycatcher	federal species of concern
Northern Goshawk	federal species of concern, state candidate
Northern Spotted Owl	federal threatened, state endangered
Olive-sided Flycatcher	federal species of concern

As discussed in the "Wildlife" section in this chapter, noise disturbance can result in behavioral and physiological reactions in wildlife that vary by species and individual (Radle 1998). Special status wildlife may experience short-term and temporary disturbances from stocking activities, such as interruption of activity or temporary flushing or fleeing, but this would not change population structure or function.

Although these 11 species may be present in nearby forests, most are expected in very limited numbers in the North Cascades Complex and are not known to nest or den in the areas immediately surrounding any of the high mountain lakes in the study area. While an occasional passing aircraft or vehicle may cause temporary disturbance and/or a flight response similar to that experienced by other species, no other impacts stemming from fish stocking would affect them. Therefore, actions under alternative A may affect, but are not likely to adversely affect any of the above 11 species.

The following 13 listed species are known to be present in the aquatic habitats of the 91 lakes or the adjacent habitats. The impacts on each species from alternative A are discussed below.

Yuma Myotis (Federal Species of Concern). Yuma myotis are insect-eating bats that forage over high mountain lakes in the North Cascades Complex. Noise from stocking activities or human presence are not expected to affect the species, though bats may experience a minimal amount of stress when roosting during the day if stocking activities occur near them. Stocked fish compete for the same insect food base as Yuma myotis. This competition in stocked lakes is not likely to noticeably affect insect availability for Yuma myotis; therefore, it may be affected, but is unlikely to be adversely affected from actions under alternative A.


Canada Lynx
American Peregrine Falcon
Northern Spotted Owl
Marbled Murrelet
Gray Wolf
Pacific Fisher
Olive-Sided Flycatcher
Grizzly Bear
California Wolverine
Little Willow Flycatcher
Northern Goshawk

Long-eared Bat (Federal Species of Concern). Long-eared bats glean insects from foliage, but also forage over water. Noise from stocking activities or human presence is not expected to affect long-eared bats. Similar to Yuma myotis, stocking activities may cause some level of stress to individuals roosting near a lake during stocking activities. Long-eared bats may be affected, but are unlikely to be adversely affected from fish stocking under alternative A.

Bald Eagle (Federal Threatened, State Threatened). Bald eagles are a common winter resident along the Skagit River and can be seen in other low-elevation riparian areas of the North Cascades Complex. There is a nest near the head of Lake Chelan that has been active since 2001. A pair of bald eagles has nested at the head of Baker Lake (within 1 to 1.5 miles of the North Cascades Complex boundary) for many years. Alternative A may affect, but is not likely to adversely affect bald eagles because they only rarely, if ever, use the stocked mountain lakes in the North Cascades Complex to forage or roost.

Harlequin Duck (Federal Species of Concern). Harlequin ducks are summer migrants that nest on the shores of larger low-gradient streams in the North Cascades Complex and are widely distributed in large tributaries of the Skagit and Stehekin rivers. They are not associated with mountain lakes, and it is unlikely that enough fry escape down the outlets of mountain lakes to contribute to their forage base. In addition, harlequin ducks primarily feed on aquatic invertebrates and only eat trout fry opportunistically. Impacts from alternative A would include a reduction in this duck's aquatic food base as a result of stocking fish that may prey on invertebrate species that occur in the same drainages. Noise impacts would occur from stocking activities but would be short term, minor, and infrequent. Implementation of alternative A, may affect, but is unlikely to adversely affect harlequin ducks.

The Harlequin duck is a federal species of concern that feeds primarily on aquatic invertebrates.

Cascades Frog (Federal Species of Concern). The North Cascades Complex is considered the northern boundary of the Cascades frogs' range (Bury and Adams 2000). Predation by nonnative trout and habitat loss throughout the frog's southern range is likely the reason for its federal status as a Species of Concern; however, the frog is not listed by the state of Washington (WDFW, D. Stinson, pers. comm., 2004).

The Cascades frog primarily inhabits small pools and streams in subalpine meadows but also occurs in bogs, marshy areas, ponds, and small lakes. The Cascades frog has been documented in three locations in the North Cascades Complex: two ponds and a stream in Bridge Creek drainages (Bury et al. 2000). The distribution of these frogs in the North Cascades Complex is likely patchy, and they are often not found in areas that appear to have suitable habitat. (Leonard et al. 1993). The status of the frog and reasons for its patchy distribution are unknown.

The species is not known to occupy larger, deeper lakes that contain fish, and it is unknown if this absence from large lakes is due to past fish predation or if the species naturally prefers shallower waters (Bury and Adams 2000). Because the species is not generally associated with lakes stocked with fish, implementation of alternative A may affect, but is not likely to adversely affect, Cascades frogs.

Columbia Spotted Frog (Federal Species of Concern, State Candidate Species). The Columbia spotted frog is a highly aquatic species that lives in mountainous areas in or near cold, slow-moving streams, springs, marshes, ponds, and small lakes without extensive emergent vegetation (Leonard 1993). In the North Cascades Complex, the Columbia spotted frog has been documented in wet meadows, seasonal streams, seeps, and various lakes and ponds at elevations ranging from 2,500 to 5,900 feet (Bury et al. 2000; Liss et al. 1995). The frog has been documented in these four lakes in the Stehekin River watershed: Dagger, McAlester, Kettling, and Coon. Two of these lakes, Dagger and McAlester, have reproducing populations of stocked trout. These lakes also have extensive meandering inlet and outlet streams that may protect the frogs from predation (OSU, B. Hoffman, pers. comm., 2003). Tadpoles metamorphose into adults during their first summer and can use temporary or shallow ponds as breeding sites that are inaccessible to predatory fish (Bull and Marx 2002; Pilliod and Peterson 2001; Llewellyn and Peterson 1998). Within the main body of lakes inhabited by the Columbia spotted frog, stocked trout limit the frog's use of the open water areas. This may reduce the number of frogs in the lake, but does not extirpate Columbia spotted frogs from the surrounding wetlands and nearby temporary ponds, which are extensive enough to support viable breeding populations of the species.

Under alternative A, Columbia spotted frogs may be affected but are not likely to be adversely affected in the lakes in which they have been documented. The number of frog larvae in the main portion of these lakes would likely be noticeably reduced in relation to a similar fishless lake, but populations of Columbia spotted frogs in the lakes that contain stocked trout would remain indefinitely viable in the North Cascades Complex.

Northern Red-Legged Frog (Federal Species of Concern). Northern red-legged frogs have been documented in wetlands and ponds along the Skagit River near Newhalem. There is no documented presence of the species in the 62 lakes containing stocked fish; however, not all lakes in the North Cascades Complex have been surveyed. Lower-elevation lakes in the Ross Lake National Recreation Area (Thunder, Hozomeen, Willow, and Ridley) have suitable habitat for northern red-legged frogs, and they have been observed in the general vicinity of Hozomeen village (URS, R. Nielsen, pers. comm., 2004). For this analysis, it is assumed that some of the 62 lakes would contain northern red-legged frogs.

Adult northern red-legged frogs are highly terrestrial, but they are typically found near ponds or streams. Although adults breed in both temporary and permanent water sources, the breeding season is short, occurring only for one to two weeks. Breeding sites must have little or no flow, must last long enough for metamorphoses to occur before the end of summer, and must contain sturdy underwater stems of some sort for egg attachment (Nussbaum et al. 1983). Northern red-legged frogs co-evolved with trout in the coastal lowlands, and these behavioral mechanisms allow them to survive. Like spotted frogs, northern red-legged frog tadpoles are able to avoid fish predation because they metamorphose into adults in shallow waters (Nussbaum et al. 1983). Under alternative A, a number of lower-elevation lakes that would continue to have fish and be stocked would contain northern red-legged frog tadpoles or breeding adults. Nonnative trout may prey on tadpoles, but this is not likely to affect the population of northern red-legged frogs in the North Cascades Complex. Therefore, northern red-legged frogs may be affected, but are not likely to be adversely affected under alternative A. The extent of impacts, nevertheless, would need to be verified through additional monitoring.

Nert Lake (shown above), along with Upper Bouck, are two of six lakes with documented populations of tailed frogs.

Tailed Frog (Federal Species of Concern). Tadpole and adult tailed frogs have been documented in the outlets of six lakes in the North Cascades Complex (including Upper Bouck and Nert lakes) that are currently stocked (Liss et al. 1995; Bury et al. 2000). Past research has shown that tailed frogs have evolved in stream environments with fish predation but are not generally found directly inhabiting lakes; instead, they are found in stream outlets. Stocked trout are likely to have minimal effects on tailed frogs in lakes (NPS, R. Glesne, pers. comm., 2003). The lakes do not provide primary habitat for tailed frogs, which are widely distributed throughout the North Cascades Complex in moderate to high-gradient streams; therefore, tailed frogs would incur no effect under alternative A or any other alternative.

Western Toad (Federal Species of Concern, State Candidate Species). Intensive surveys of the Big Beaver Valley in the early 1970s indicated that Western toads were common in a variety of habitat types, except in rockslides (Taber 1974). More recent amphibian surveys in North Cascades Complex found a fragmented distribution of adult Western toads in or near four lakes considered in this analysis: Battalion, Lower Thornton, Trapper, and Willow (Liss et al. 1995). Tadpoles were observed at Trapper Lake. Western toad tadpoles and adults are probably not preyed upon by trout because they secrete a toxin (Corn 1998) that is unpalatable to trout (Llewellyn and Peterson 1998; Bury and Adams 2000; Tyler et al. 2003). For these reasons, Western toads would not be affected under alternative A.

The federally listed fish species in the North Cascades Complex inhabit rivers downstream from the high mountain lakes addressed in this plan/EIS. The level of effect on these downstream fish communities would be expected to vary depending on several factors: whether there is a connection from the lake to a downstream basin (an outlet); the species of trout stocked; the extent of reproduction in a lake; and the species of native fish in the downstream watershed. Impacts were assessed using the same predictive factors identified for impacts to nonlisted native fish as a guidance and considering the evidence of colonization and/or hybridization reported for these species (WDFW, M. Downen, pers. comm., 2004). A more detailed evaluation for each of the listed fish species is provided below.

Bull Trout (Federal Threatened, State Candidate). Bull trout are found in the Chilliwack, Skagit, and Ross drainage basins on the west side of the Cascade Crest, and juveniles are found in the higher stream reaches. Bull trout were once found on the east side of the crest; however, they have been extirpated from those drainages, and the NPS and other agencies are interested in restoration. Bull trout on the west side of the Cascade Crest are at risk from hybridization and/or competition from introduced fish in upstream lakes that are connected to the west-side drainages. In addition, fish that might enter downstream drainages may also enter the forage base for bull trout.

The lower Skagit River harbors one of the most robust populations of bull trout in the western United States. WDFW estimates (based on available habitat, spawning surveys, and fishery interceptions rates) range from 10,000 to 15,000 migratory adults. Strong populations (greater than 100 spawning individuals annually) in the Skagit core area occur in every major sub-basin of the Skagit including the Baker, Sauk, Whitechuck, Suiattle, Cascade, and mainstem. Consequently, the Skagit is one of only two river systems where a recreational fishery is still managed, allowing the retention of two fish per day over 20 inches (WDFW, M. Downen, pers. comm., 2004).

The major tributaries in the North Cascades Complex that are used by bull trout for spawning below the Seattle City Light projects include Bacon Creek, Goodell Creek, Marble Creek, and the South Fork of the Cascade. The populations in Bacon and Goodell creeks are part of WDFW's long-term monitoring program, and both Marble and the South Fork of the Cascade are sampled periodically. Bacon, Goodell, and Marble creeks all support populations of over 100 spawning adults, and the South Fork of the Cascade supports more than 500 spawning adults. Other lesser tributaries such as Thornton, Damnation, Day, Lookout, and Sibley are not spawning tributaries but are frequented by sub-adult and adult fish in search of foraging opportunities (WDFW, M. Downen, pers. comm., 2004).

Bull trout probably colonized the upper Skagit Basin above the Seattle City Light projects shortly after the last glacial recession and are now considered a separate population from the lower Skagit. In the Ross basin, which is part of the larger upper Skagit core population, bull trout show a life history analogous to the anadromous life history shown in the lower Skagit. Major spawning tributaries within the North Cascades Complex boundary include Ruby, Big Beaver, Lightning, Silver, and Little Beaver creeks (WDFW, M. Downen, pers. comm., 2004).

Both brook trout and nonnative westslope cutthroat trout present potential threats to bull trout in west-side drainages connected to lakes containing these species. The primary concern is the potential for hybridization with introduced brook trout, which would affect the reproductive success of the bull trout population. Brook trout occur in three west-side lakes within the Baker and Ross drainage basins: Hozomeen, Blum (Lower West No. 4), and Sourdough. The potential for hybridization between the bull trout and brook trout is of particular concern in Hozomeen Creek in the Ross watershed, but hybridization has not yet been documented (WDFW, M. Downen, pers. comm., 2004). The lack of hybridization may be related to differences in spawning habitat because brook trout tend to spawn in warmer water, while bull trout spawn in very cold water.

Potential impacts on bull trout would also result from competition for resources and predation on juvenile bull trout inhabiting upper stream reaches if either westslope cutthroat or brook trout are stocked in west-side lakes. The nonnative, more mature resident fish would disperse to downstream drainages and prey upon juvenile char.

There are currently 21 west-side lakes (see table G-5 in appendix G) containing brook or westslope cutthroat trout that have outlets to drainages with bull trout populations, but not all drain to spawning tributaries (WDFW, M. Downen, pers. comm., 2004). In addition, studies in Montana and other regions where westslope cutthroat co-occur suggest the two species co-exist, although some competition has been observed. Overall, the extent of the impacts from competition and predation is likely minor, although more data would be required to more accurately assess this impact.

In summary, the potential impacts on bull trout from westslope cutthroat trout are likely minor and related mainly to competition for resources. The impacts on bull trout from introduced brook trout would be more serious if colonization and hybridization would occur, but information from WDFW about the four lakes containing brook trout indicate this has not occurred in the downstream drainages; therefore, alternative A may affect, but is not likely to adversely affect, bull trout.

Chinook Salmon (Federal Threatened). Chinook (king) salmon occur in the lower reaches of the Skagit River and its major tributaries and in the mainstem of the Baker River. Hybridization with nonnative fish is not known to occur, and attempted hybridization between Chinook and nonnative species has not been successful. There is a slight possibility that if mature stocked fish migrate from lakes to downstream drainages containing Chinook salmon, they may affect Chinook salmon through competition. This effect, though, is questionable given their vastly different life histories. Also, predation is unlikely because westslope cutthroat trout generally do not consume young fish but rather feed on aquatic and terrestrial insects.

Currently, there are reproducing westslope cutthroat trout in 13 lakes in the Skagit basin and reproducing brook trout in 1 lake in the Baker drainage basin (see table G-5 in appendix G). Considering the fact these fish would not likely colonize as far downstream as Chinook are found, and the lack of hybridization and predation potentials, alternative A may affect, but is not likely to adversely affect Chinook salmon.

Coho Salmon (Federal Candidate Species, State Candidate Species). The Georgia Strait/Puget Sound Evolutionarily Significant Unit (ESU) of Coho salmon inhabits the Skagit, Baker, and Chilliwack rivers and their higher-order, lower-gradient tributaries. Coho salmon spend their first year in the birth tributary and the next 18 months in the ocean before returning to spawn from November through early February. Because the young spend roughly one year in freshwater before smolting (when young salmon swim to the ocean), they must compete with other native salmonids and potentially with introduced fish dispersing downstream. Hybridization with nonnative fish does not occur.

Reproducing westslope cutthroat trout are currently in 15 lakes in the Skagit Basin, and reproducing brook trout are in 1 lake in the Baker drainage basin and 2 lakes in the Ross drainage basin (see table G-5 in appendix G). Impacts on Coho salmon would be limited because of the lack of potential for hybridization or predation by westslope cutthroat trout, as described above for Chinook salmon; therefore, alternative A may affect, but is unlikely to adversely affect Coho salmon.

Westslope Cutthroat Trout (Federal Species of Concern). Westslope (inland) cutthroat trout are native to the Stehekin River and its tributaries on the east side of the Cascade Crest, though the species was introduced to stream basins on the west side of the Cascade Crest, where it is considered a threat to west-side native fish. Within the westslope cutthroat trout's native range on the east side, introduced stocks of rainbow trout in Lake Chelan and various other lakes at the headwaters of the Stehekin River have replaced some native populations of westslope cutthroat trout through either competition between the species or hybridization (Behnke 1992). Recent genetic research has demonstrated that rainbow trout dispersing downstream from stocked mountain lakes in the Stehekin drainage are responsible for some of the hybridization (WFRC, C. Ostberg, pers. comm., 2004). There are two genetically "pure" strains of westslope cutthroat still present in the headwaters of the Stehekin River drainage and in Park Creek, Flat Creek, and likely, Bridge Creek. The persistence of these two pure strains may be related to water temperature because rainbow trout do not appear to be able to spawn in the colder waters of the Stehekin drainage (WFRC, C. Ostberg, pers. comm., 2004).

Under alternative A, nine lakes in the Stehekin basin with stream outlets have reproducing rainbow or rainbow/cutthroat hybrid trout that would adversely impact native westslope cutthroat trout inhabiting downstream drainages. Documentation of colonization and hybridization has been confirmed in one downstream drainage (outlet to McAlester Lake). Based on the evidence, native westslope cutthroat trout may be affected and are likely to be adversely affected in at least one lake through hybridization by introduced rainbow/cutthroat trout under alternative A.

State-Listed Wildlife Species. Under alternative A, six species listed at the state level (black-backed woodpecker, golden eagle, Lewis' woodpecker, merlin, pileated woodpecker, and Vaux's swift) would experience negligible to minor adverse impacts from fish stocking or associated activities. Noise impacts from aircraft stocking or human presence may temporarily flush one of these state candidate species, as previously described for several federally listed species, but would not result in any detrimental effects to populations.

The common loon (Washington State sensitive species) would incur negligible adverse impacts. Continuation of fish stocking would provide beneficial effects by supporting an adequate food base for nesting common loons near Hozomeen Lake or other stocked lakes.

Cumulative Impacts

Cumulative impacts on special status species are considered for past, present, and future projects occurring in the North Cascades Complex or on lands outside the North Cascades Complex boundary. No new major roads, trails, resorts, or major upgrades of facilities are proposed or in the planning stages. Some access had been eliminated or reduced due to flooding of trails. Visitor use is expected to remain at about the same levels it has been for several years, resulting in about the same level of human presence near most lakes and connected streams. Human recreational use of the lakes and surrounding drainages may cause adverse impacts on special status species in the North Cascades Complex due to noise and disturbance associated with human presence. However, some of this disturbance to listed species from backpackers, campers, and anglers would be mitigated by the natural topography of the landscape (which can provide sound or visual buffering) and the forested areas that provide refuge for wildlife. In addition, sport and commercial fishing may also result in direct adverse impacts on salmon populations in the Pacific Northwest.

Mountain lake fisheries on National Forest System lands that surround the North Cascades Complex are managed by the WDFW. The department's management history is described in WDFW (2001), and management would continue to evolve with continued interest in the stocking of native species. Lakes stocked in the past are assumed to have a range of impacts on special status species similar to what has been analyzed for the North Cascades Complex lakes, which varies from no effect, to may affect, to likely to adversely affect, depending on the species. On a landscape scale, the piscivorous species generally benefit from the presence of stocked fish in mountain lakes where resources were previously lacking. Because stocking has occurred in previously fishless lakes, fish-eating species, such as ospreys, have expanded their territories and home ranges, which benefits individuals. However, ecologically speaking, introduction of nonnative species is considered detrimental to community dynamics of a listed species. A species already considered threatened or endangered due to its rarity would potentially face an increasing threat of local extirpation through nonnative species competition, predation, or hybridization. Continued presence of fish in North Cascades Complex lakes, coupled with continued presence of fish in lakes on surrounding lands, would tend to make piscivorous species more widespread and increase their populations.

There would be continued, localized, and sporadic effects on special status wildlife species from logging and water projects occurring outside the North Cascades Complex, including in connected watersheds. These actions can cause severe habitat loss for many species of plants and animals, particularly, listed salmon species that are unable to return to spawning habitat. Logging along the Pacific Coast has caused siltation and reduced shade cover, resulting in increased stream temperature to lethal levels for the juveniles and eggs to survive.

Other sources of impacts continue to occur that may affect the health and viability of species dependent on aquatic resources. There is concern about persistent organic pollutants and methyl-mercury found in some lakes in the North Cascades Complex, which appear to result from airborne pollutants being deposited on snow and washed into lakes. There is the potential for increased acid rain from emissions related to the development of an additional power plant in the area; emissions would contribute to an increase in lake acidity and metal availability. In some cases, the concentrations of some of these pollutants in the water in preliminary studies appear to be high enough to raise concerns that, in conjunction with other influences, higher trophic-level organisms may be affected. Toxins can be passed from the tissue of one organism to those that feed on it, meaning that a toxin can move up the food chain and bioaccumulate to higher concentrations in the top predators, such as bald eagles, to the point where they cause reproductive failure. If that occurred, then the cumulative impacts of the pollutants coupled with other impacts, perhaps from fish, might eliminate that predator species from certain lakes or even cause a more general decline in the population.

Alternative A, combined with other actions in the area, may affect, and is likely to adversely affect special status species in the study area on a cumulative basis, especially special status amphibians and fish. The actions under alternative A, however, only add small incremental impacts to the potential overall impacts on listed species and affect one species of native fish (westslope cutthroat trout). Also, an accurate determination of the magnitude of cumulative impacts on each special status species cannot be made because available information and research on each species' biology, status, and distribution is insufficient. Additional research and population monitoring of special status species that would be affected by the alternatives in this plan/EIS, combined with research completed in the region, would help to better determine cumulative impacts.

Conclusion

Based on available information, fixed-wing aircraft noise and human disturbance associated with periodic fish stocking activities under alternative A would have a range of short-term negligible to minor effects on special status wildlife species. Fish removal does not occur under alternative A, so there would be no impacts on special status wildlife species from lake treatments to remove fish.

Based on the available information, alternative A would have ***no adverse effects on federally listed species*** from fish stocking. Regarding ***federally listed species:***

> **21 species may be affected but are not likely to be adversely affected** (American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, marbled murrelet, Northern goshawk, Northern spotted owl, Pacific fisher, Yuma myotis, long-eared bat, bald eagle, harlequin duck, little willow flycatcher, olive-sided flycatcher, Cascades frog, Columbia spotted frog, northern red-legged frog, bull trout, Chinook salmon, Coho salmon).
>
> **2 species would incur no effect** (tailed frog and Western toad).
>
> **1 species may be affected and is likely to be adversely affected** (westslope cutthroat trout)—effects would be limited to one drainage downstream from McAlester Lake as a result of documented hybridization and colonization.

Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts (solely from noise related to stocking activities), and the common loon would incur short-term negligible adverse impacts. Continuation of stocking would provide beneficial effects by supporting an adequate food base for nesting loons near Hozomeen Lake and other stocked lakes.

Cumulative impacts on each special status species from projects or actions occurring throughout the region would be adverse; however, alternative A would contribute only a small increment to overall cumulative impacts.

Impairment of special status wildlife species across the study area would not occur under alternative A.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

The emphasis of this alternative would be to eliminate or reduce reproducing fish from lakes in the study area (refer to tables 4 and 5 in the "Alternatives" chapter). Restocking of nonreproducing fish would be allowed only where biological resources would be protected. Based on best available science, some lakes would be restocked with nonreproducing fish at low densities once reproducing fish have been removed. An extensive monitoring program (see appendix F), which includes adaptive management provisions, would be implemented to avoid unacceptable future effects on native biota.

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

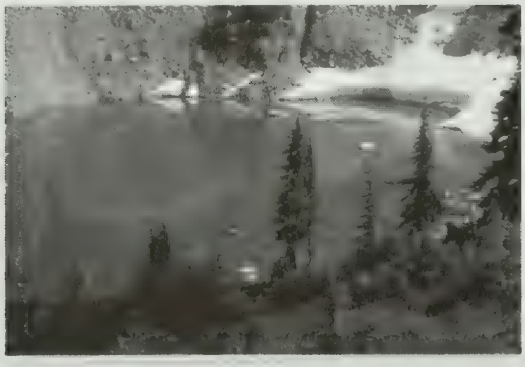
Impacts of Proposed Fish Stocking and Lake Treatment Methods on Special Status Wildlife Species

Similar to alternative A, alternative B may affect, but is not likely to adversely affect, any of the 11 species listed below that either do not depend on lake resources or only eat fish opportunistically, or they would not be disturbed by activities associated with fish stocking or lake treatments to remove fish.

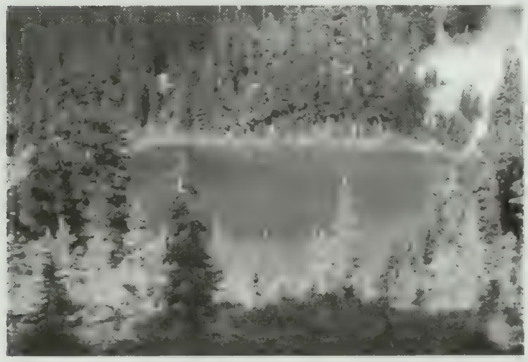
American Peregrine Falcon	federal species of concern, state candidate
California Wolverine	federal species of concern, state threatened
Canada Lynx	federal threatened, state threatened
Gray Wolf	federal endangered, state endangered
Grizzly Bear	federal threatened, state endangered
Pacific Fisher	federal species of concern, state endangered
Marbled Murrelet	federal threatened, state threatened
Little Willow Flycatcher	federal species of concern

Northern Goshawk	federal species of concern, state candidate
Northern Spotted Owl	federal threatened, state endangered
Olive-sided Flycatcher	federal species of concern

Both of the lakes pictured below have a high density of reproducing fish.



Blum Lake–Largest/Middle No. 3



Blum Lake–Lower/West No. 4

The following 13 listed species are known to be present in the aquatic habitats of the 91 lakes or the adjacent habitats. The impacts on each species from alternative B are discussed below.

Yuma Myotis (Federal Species of Concern). Similar to alternative A, Yuma myotis may be affected, but are unlikely to be adversely affected from actions under alternative B. Yuma myotis bats may experience a minimal amount of stress if stocking or treatment activities occur near a diurnal (daytime) roost. Competition for insects with fish in stocked lakes is not likely to noticeably affect insect availability for Yuma myotis.

Long-eared Myotis (Federal Species of Concern). Similar to alternative A, long-eared myotis may be affected but are unlikely to be adversely affected from actions under alternative B. Long-eared bats may experience minor stress if stocking or treatment activities occur near a diurnal (daytime) roost. Competition for insects with fish in stocked lakes is unlikely to affect insect availability for long-eared myotis.

Bald Eagle (Federal Threatened, State Threatened). Similar to alternative A, alternative B may affect, but is not likely to adversely affect, bald eagles because they only rarely, if ever, use the high-elevation stocked lakes in the North Cascades Complex to forage or roost.

Harlequin Duck (Federal Species of Concern). Similar to alternative A, implementation of alternative B, may affect, but is unlikely to adversely affect, harlequin ducks because implementation of alternative B would potentially reduce the aquatic food base for the species due to competition with introduced trout. In addition, noise impacts would occur from stocking activities but would be short term, minor, and infrequent.

Cascades Frog (Federal Species of Concern). The status and distribution of Cascades frogs in the North Cascades Complex is generally unknown, but the species has been documented in two ponds and one stream location in the Bridge Creek drainage (Bury et al. 2000). Because the species is not generally associated with lakes stocked with fish, implementation of alternative B, may affect, but is not likely to be adversely affect Cascades frogs. Removal of fish in high mountain lakes may serve to benefit Cascades frogs if their absence in larger, deeper lakes was due to past predation by nonnative fish.

Columbia Spotted Frog (Federal Species of Concern, State Candidate Species). Under alternative B, one of the lakes containing Columbia spotted frogs (Kettling Lake) would be chemically treated to become fishless. Two lakes, Dagger and McAlester, would be chemically treated to remove all reproducing fish. The lakes would be evaluated to determine if restocking is advisable, and these lakes would be stocked with nonreproducing fish at low densities. Coon Lake would continue to be stocked at low densities under alternative B. These three lakes (Dagger, McAlester, and Coon) have extensive meandering inlet and outlet streams that may protect the frogs from fish predation (OSU, Hoffman, pers. comm., 2003). Within the main body of lakes inhabited by the Columbia spotted frog, stocked fish likely limit frog use. This may reduce the number of frogs in the lake, but it would not eliminate spotted frogs from the surrounding wetlands and nearby temporary ponds, which are extensive enough to support viable breeding populations of the species.

Under alternative B, Columbia spotted frogs may be affected but are not likely to be adversely affected in the lakes where stocking would continue. The number of frog larvae in the main portion of stocked lakes would likely be noticeably reduced in relation to a similar fishless lake. Populations of Columbia spotted frogs in the lakes that contain stocked trout would remain viable in the North Cascades Complex indefinitely. Also, populations of frogs in lakes that would become fishless under alternative B would not incur further impacts from fish predation. Moreover, the reduction in fish density and the elimination of fish would be a beneficial effect to the frogs.

Chemical treatment with antimycin to remove fish in Kettling, Dagger, McAlester, and Coon lakes may affect, but is unlikely to adversely affect, Columbia spotted frogs. As discussed in the "Aquatic Organisms" section in this chapter, the use of antimycin is not known to have adverse impacts on amphibians. Impacts on northern Columbia spotted frogs from trampling would be mitigated to the greatest extent possible, as described in appendix I.

Northern Red-Legged Frog (Federal Species of Concern). As described in alternative A, Northern red-legged frogs have been documented in wetlands and ponds along the Skagit River near Newhalem and in the Big Beaver valley but have not been confirmed in the 62 lakes in the study area that currently contain fish because surveys have not been completed. Lower-elevation lakes in the Ross Lake National Recreation Area (Thunder, Hozomeen, Willow, and Ridley) have suitable habitat for the species and would contain northern red-legged frogs.

Under alternative B, maintaining Thunder Lake as fishless and chemically removing fish from Hozomeen Lake would result in long-term beneficial effects to any red-legged frogs present in these lakes. As discussed in the "Aquatic Organisms" section in this chapter, the use of antimycin may have short-term adverse impacts on amphibians. Impacts on northern red-legged frogs from trampling or other disturbance related to lake treatment would be mitigated to the greatest extent possible, as described in the appendix I. If northern red-legged frogs are found to occur in Willow or Ridley lakes, nonnative fish may prey on northern red-legged frog tadpoles. The species may be affected, but are not likely to be adversely affected, by stocked fish in those lakes. Adverse impacts from nonnative fish are not likely to affect the population of northern red-legged frogs in the North Cascades Complex. The extent of the impacts would need to be verified through monitoring.

Tailed Frog (Federal Species of Concern). Tadpole and adult tailed frogs have been documented in the outlets of six lakes in the North Cascades Complex, including Upper Bouck and Nert lakes (Liss et al. 1995; Bury et al. 2000), which are currently stocked. The lakes would no longer be stocked under alternative B and would eventually become fishless. Some populations of tailed frogs have evolved in stream environments with fish predation (NPS, R. Glesne, pers. comm., 2003). In the North Cascades Complex, many populations are found in high-gradient tributaries that are inaccessible to fish. Under alternative B, threats to tailed frogs from predatory fish would cease. Removal of fish in Upper Bouck and Nert lakes would occur simply through discontinued stocking, and therefore, alternative B would have no effect on tailed frogs in the North Cascades Complex.

Western Toad (Federal Species of Concern, State Candidate Species). Recent amphibian surveys in North Cascades Complex found a fragmented distribution of adult Western toads in or near four lakes considered in this analysis: Battalion, Lower Thornton, Trapper, and Willow (Liss et al. 1995). Tadpoles were observed at Trapper Lake. Battalion Lake would be treated to remove all fish and then monitored to evaluate for restocking after additional data is gathered. Dagger Lake would be evaluated to determine if fish removal is feasible; if not, then fish density would be reduced. The remaining lakes would continue to be stocked at low densities. Western toad tadpoles and adults are probably not preyed upon by trout because they secrete a toxin (Corn 1998) that is unpalatable to trout (Llewellyn and Peterson 1998; Bury and Adams 2000; Tyler et al. 2003). For these reasons, Western toads would not be affected under alternative B. Fish in Battalion Lake would be removed using chemical treatment methods, and as discussed in the "Aquatic Organisms" section in this chapter, the use of antimycin is not known to have adverse impacts on amphibians. Impacts on Western toads from trampling during lake treatments would be mitigated to the greatest extent possible, as described in appendix I. Based on potential minor disturbance from lake treatment activities, Western toads may be affected, but are unlikely to be adversely affected by actions under alternative B.

Bull Trout (Federal Threatened, State Candidate). Under alternative B, the potential for future adverse impacts on bull trout would be reduced compared to alternative A, and there would be a long-term beneficial effect on the species from removal of fish and reduction in fish densities. Of particular benefit to bull trout would be the eventual removal of brook trout from Hozomeen and Sourdough lakes, reducing the possibility of hybridization between bull and brook trout. Two lakes (Lower Thornton and Firn) would continue to contain nonnative westslope cutthroat trout; however, Lower Thornton does not drain to bull trout spawning tributaries where competition would be an issue. Cutthroat in Thornton Creek would probably provide sub-adult bull trout with a foraging opportunity. Moreover, there is currently no evidence of widespread distribution of westslope cutthroat in the Skagit River. To the contrary, snorkeling surveys only note occasional occurrence of individuals of the species. It is unlikely that the few low-density westslope trout in these lakes would adversely affect bull trout; therefore, actions in alternative B may affect, but are not likely to adversely affect, bull trout.

Chinook Salmon (Federal Threatened). Under alternative B, 24 lakes in the Baker and Skagit basins would be treated to remove fish or decrease fish densities (refer to table G-5 in appendix G), and the potential for adverse impacts on Chinook salmon would eventually be eliminated in these basins. These actions would have long-term beneficial effects on Chinook salmon. One lake in the Skagit basin (Lower Thornton) would continue to have reproducing westslope cutthroat trout, but this would not cause impacts on native Chinook salmon in that basin from competition and predation, as explained under alternative A. Chinook salmon are not likely to be in upstream reaches near the lake, and the fish density would be maintained at low levels; therefore, alternative B may affect, but is not likely to adversely affect, Chinook salmon in the study area.

Coho Salmon (Federal Candidate Species, State Candidate Species). Under alternative B, 26 lakes in the Baker, Skagit, and Chilliwack basins would be treated to remove fish or decrease fish densities, and the potential for adverse impacts on Coho salmon would eventually be eliminated in these basins (refer to table G-5 in appendix G). This reduction in density and elimination of fish would have long-term beneficial effects to Coho salmon. One lake in the Skagit basin (Lower Thornton) would continue to have reproducing westslope cutthroat trout, which would not cause impacts on native Coho salmon in that basin from competition and predation, as explained under alternative A. Alternative B may affect, but is not likely to adversely affect Coho salmon in the study area.

Westslope Cutthroat Trout (Federal Species of Concern). Under alternative B, reproducing populations of rainbow cutthroat hybrid trout would be removed from McAlester Lake, where evidence of downstream colonization and hybridization has been confirmed. Westslope cutthroat trout in downstream drainages would incur long-term beneficial effects from the elimination of nonnative reproducing fish in this lake. Actions under alternative B, may affect, but are not likely to adversely affect westslope cutthroat trout in its native range, although it is recognized that until all reproducing nonnative fish are removed from McAlester Lake, the potential for continued hybridization with westslope cutthroat trout would exist.

State Listed and Other Special Status Wildlife Species. Under alternative B, six species (black-backed woodpecker, golden eagle, Lewis' woodpecker, merlin, pileated woodpecker, and Vaux's swift) may incur minor impacts from fish stocking and lake treatment activities. Noise impacts from fixed-wing aircraft, helicopters, or human presence may temporarily flush individuals of these state candidate species if present near a lake when stocking or treatment activities are occurring, but this would not result in any detrimental impacts on these wildlife species.

The common loon (Washington State sensitive species) would be adversely affected by actions under alternative B because stocked fish would be removed from Hozomeen Lake. This may result in minor to moderate impacts on the pair of breeding loons that has nested at Hozomeen Lake since at least 1971. Adequate fish resources to support a family of loons may exist in nearby Ross, Ridley, and Willow lakes. Loons are declining in Washington due to the loss of low-elevation lake habitats and associated human disturbances (Richardson et al. 2000). While the loss of habitat at Hozomeen Lake is unlikely to affect the overall population of common loons, at the local level, the breeding pair of loons would be displaced from Hozomeen Lake and either would choose an adjacent area to nest or would stop nesting in the North Cascades Complex. Therefore, common loons would incur minor to moderate adverse impacts under alternative B.

Cumulative Impacts

Under alternative B, cumulative impacts on special status species would be similar to those described for alternative A. There would, however, be a reduction of impacts on native fish in several drainages and on amphibians due to the eventual removal of fish in 20 lakes and replacement of high-density reproducing fish with lower-density nonreproducing fish in others.

Overall, the impacts associated with other projects, uses, and actions occurring in the region (as described under alternative A), added to the impacts predicted under alternative B, may affect, and are likely to adversely affect certain special status species in the region on a cumulative basis. However, the actions under alternative B add only small incremental impacts to the potential overall impacts on listed species, and only for one species of native fish (westslope cutthroat trout). Also, an accurate determination of the magnitude of cumulative impacts on special status species cannot be made because available information and research on species' biology, status, and distribution is insufficient. Additional research and population monitoring of special status species that would be affected by this plan/EIS, combined with research completed in the region, would help to better determine cumulative impacts.

Conclusion

Fixed-wing aircraft noise and human disturbance associated with periodic fish-stocking activities under alternative B would have a range of short-term negligible to minor effects on some special status wildlife species but would be reduced from the effects that would occur under alternative A. Short-term impacts related to lake treatments to remove fish would be minor, mostly due to noise from helicopters transporting lake treatment equipment and human disturbance during treatment activities. The use of the chemical, antimycin, to remove fish is not known to have adverse impacts on amphibians. There would be long-term beneficial effects on some aquatic species because most high-density reproducing populations of fish would be replaced with low-density nonreproducing stocked fish.

Based on the available information, alternative B would have ***no adverse effects on federally listed species*** from fish stocking or lake treatments to remove fish. Regarding ***federally listed species:***

> **23 species may be affected but are not likely to be adversely affected** (American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, little willow flycatcher, marbled murrelet, Northern goshawk, Northern spotted owl, olive-sided flycatcher, Pacific fisher, Yuma myotis, long-eared bat, bald eagle, harlequin duck, Cascades frog, Columbia

spotted frog, northern red-legged frog, Western toad, bull trout, Chinook salmon, Coho salmon, westslope cutthroat trout).

1 species would incur no effect (tailed frog).

Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts from noise related to stocking and lake treatment activities, and the common loon would incur long-term minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake.

Cumulative impacts on each special status species from projects or actions occurring throughout the region would be adverse; however, alternative B would contribute only a small increment to overall cumulative impacts.

Impairment of special status wildlife species across the study area would not occur under alternative B.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

The goal of this alternative is to eliminate all fish in lakes in the national park and reduce or eliminate reproducing fish in the Lake Chelan and Ross Lake National Recreation Areas, but still allow for some sport fishing in the two recreation areas.

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter and appendix E.

Impacts from Proposed Fish Stocking and Lake Treatment Methods on Special Status Wildlife Species

Similar to alternatives A and B, alternative C may affect, but is not likely to adversely affect, any of the following 11 species because they either do not depend on lake resources or only eat fish opportunistically, or would not be disturbed by activities associated with fish stocking or lake treatments to remove fish.

American Peregrine Falcon	federal species of concern, state endangered
California Wolverine	federal species of concern, state candidate
Canada Lynx	federal threatened, state threatened
Gray Wolf	federal endangered, state endangered
Grizzly Bear	federal threatened, state endangered

Pacific Fisher	federal species of concern, state endangered
Marbled Murrelet	federal threatened, state threatened
Little Willow Flycatcher	federal species of concern
Northern Goshawk	federal species of concern, state candidate
Northern Spotted Owl	federal threatened, state endangered
Olive-sided Flycatcher	federal species of concern

The following 13 listed species are known to be present in the aquatic habitats of the 91 lakes or the adjacent habitats. The impacts on each species from alternative C are discussed below.

Yuma Myotis (Federal Species of Concern). Yuma myotis may be affected, but are unlikely to be adversely affected from actions under alternative C. Yuma myotis bats may experience a minimal amount of stress when roosting during the day if stocking or treatment activities occur near a roost.

Long-eared Myotis (Federal Species of Concern). Long-eared myotis may be affected but are unlikely to be adversely affected from actions under alternative C. The species may experience a minor stress if stocking or treatment activities occur near a roost.

Bald Eagle (Federal Threatened). Similar to alternative A, alternative C may affect but is not likely to adversely affect bald eagles because they only rarely, if ever, use the high-elevation stocked lakes in the North Cascades Complex to forage or roost.

Harlequin Duck (Federal Species Of Concern). Similar to alternative A, implementation of alternative C, may affect, but is unlikely to adversely affect harlequin ducks, as implementation of alternative C may result in a slight reduction in the availability of invertebrates due to competition with introduced trout. In addition, noise impacts would occur from stocking activities, but would be short term, minor, and infrequent.

Cascades Frog (Federal Species of Concern). In the North Cascades Complex, the Cascades frog has been documented in two ponds and one stream location in the Bridge Creek drainage (Bury et al. 2000). The species seems to be absent from lakes stocked with fish; however, it is unknown if this is due to predation from stocked trout or a preference for shallower waters. For these reasons, implementation of alternative C, may affect, but is not likely to adversely affect, Cascades frogs. Removal of fish in some high mountain lakes under alternative C would provide an overall benefit for Cascades frogs if their absence in larger, deeper lakes was due to past predation by nonnative fish.

Columbia Spotted Frog (Federal Species of Concern, State Candidate Species). Under alternative C, Coon Lake, which contains Columbia spotted frogs, would continue to be stocked with low densities of fish, while chemical

treatment methods would be used to remove fish in Kettling and Dagger lakes. McAlester would be chemically treated to remove all reproducing fish and would then be evaluated to determine if restocking is advisable, so there may be fish stocked again in this lake but at low densities. Impacts on Columbia spotted frogs in these lakes would be similar to those described for the species under alternative B, and long-term benefits would occur from the removal of fish in other mountain lakes. Under alternative C, Columbia spotted frogs may be affected but are not likely to be adversely affected, by stocking or treatment activities.

Northern Red-Legged Frog (Federal Species of Concern). Under alternative C, Hozomeen Lake would be chemically treated to remove fish, while Willow and Ridley lakes would continue to be stocked at low densities. Because fish would remain in Willow and Ridley lakes, Northern red-legged frogs may be affected, but are not likely to be adversely affected, by stocked fish under alternative C, similar to impacts described in alternative B. Northern red-legged frogs would experience long-term beneficial effects from removal or reduction of fish in other lakes, and the extent of adverse impacts would need to be verified through monitoring.

Tailed Frog (Federal Species of Concern). Tadpole and adult tailed frogs have been documented in the outlets of six lakes in the North Cascades Complex, including Upper Bouck and Nert lakes (Liss et al. 1995; Bury et al. 2000), which are currently stocked. The lakes would no longer be stocked under alternative C and would eventually become fishless. Some populations of tailed frogs have evolved in stream environments with fish predation (NPS, R. Glesne, pers. com., 2003). In the North Cascades Complex, many populations are found in high-gradient tributaries that are inaccessible to fish. Under alternative C, threats to tailed frogs from predatory fish would cease. Removal of fish in Upper Bouck and Nert lakes would occur simply through discontinued stocking, and therefore, alternative C would have no impact on tailed frogs in the North Cascades Complex.

Western Toad (Federal Species of Concern, State Candidate Species). Recent amphibian surveys in North Cascades Complex found a fragmented distribution of adult Western toads in or near four lakes considered in this analysis: Battalion, Lower Thornton, Trapper, and Willow (Liss et al. 1995). Tadpoles were observed at Trapper Lake. Battalion Lake would be treated to remove all fish and then monitored to evaluate for restocking after additional data is gathered. Lower Thornton Lake would become fishless under alternative C, and Willow Lake would continue to be stocked at low densities. If feasible, fish would be removed from Trapper Lake. Western toad tadpoles and adults are probably not preyed upon by trout because they secrete a toxin (Corn 1998) that is unpalatable to trout (Llewellyn and Peterson 1998; Bury and Adams 2000; Tyler et al. 2003). For these reasons, Western toads would not be affected under alternative C. Impacts on Western toads from continued stocking activities or lake treatment would be similar to those discussed in alternative B and be limited to very localized disturbances from human presence and habitat trampling. Western toads may be affected, but are unlikely to be adversely affected, by actions under alternative C; nevertheless, long-term beneficial impacts on western toads would result from removal or reduction of fish in these lakes.

Bull Trout (Federal Threatened). Under alternative C, all lakes that connect to drainages containing bull trout either would be treated to have fish removed or treated and then stocked with low densities of nonreproducing fish; therefore, the potential for hybridization with bull trout and/or competition for resources would be unlikely under this alternative. Because lake treatment would occur over an extended period of time, and reproducing fish would not be removed from high mountain lakes immediately, it is recognized that bull trout in the Hozomeen and Sourdough drainages would be at some risk until all reproducing populations of nonnative trout were removed. Long-term beneficial effects would be realized as the program is completed. Bull trout may be affected, but are unlikely to be adversely affected, by fish stocking activities under alternative C.

Chinook Salmon (Federal Threatened). Under alternative C, all lakes that connect to drainages containing Chinook salmon either would be treated to have fish removed or treated and then stocked with low densities of nonreproducing fish; therefore, the potential for predation or competition for resources would be very low under this alternative. Because lake treatment would occur over an extended period of time, and reproducing populations of fish would not be removed from high mountain lakes immediately, it is recognized that some impacts from stocked fish would occur until all reproducing populations of nonnative trout were removed. Long-term beneficial effects would be realized as the program is completed. Chinook salmon may be affected, but are unlikely to be adversely affected, by fish stocking activities under alternative C.

Coho Salmon (Federal Candidate Species, State Candidate Species). Under alternative C, all lakes that connect to drainages containing Coho salmon either would be treated to have fish removed or treated and then stocked with low densities of nonreproducing fish; therefore, the potential for predation or competition for resources would be very low under this alternative. Because lake treatment would occur over an extended period of time, and reproducing populations of fish would not be removed from high mountain lakes immediately, it is recognized that some impacts from stocked fish would occur until all reproducing populations of nonnative trout were removed. Long-term beneficial effects would be realized as the program is completed. Coho salmon may be affected, but are unlikely to be adversely affected, by fish stocking activities under alternative C.

Westslope Cutthroat Trout (Federal Species of Concern). Impacts on westslope cutthroat trout under alternative C would be the same as described for alternative B, with long-term beneficial effects from the reduction in density and elimination of nonnative reproducing fish, especially in McAlester Lake. Actions under alternative C, may affect, but are not likely to adversely affect, westslope cutthroat trout, although it is recognized that until all reproducing fish were removed from McAlester Lake, the potential for continued hybridization with westslope cutthroat trout would exist.

State Listed and Other Special Status Wildlife Species. Under alternative C, six species (black-backed woodpecker, golden eagle, Lewis' woodpecker, merlin, pileated woodpecker, and Vaux's swift) may be affected, but are not likely to be adversely affected, by fish stocking and lake treatment activities. Noise impacts from fixed-wing aircraft, helicopters, or human presence may temporarily flush individuals of these state candidate species if they are present near a lake when stocking or treatment activities are occurring, but this would not result in any detrimental impacts on these wildlife species.

The common loon (Washington State sensitive species) may be adversely affected by actions under alternative C because stocked fish would be removed from Hozomeen Lake. Impacts would be the same as described for alternative B, which would be minor to moderate impacts on the pair of breeding loons that has nested at Hozomeen Lake since at least 1971. Adequate fish resources to support a family of loons may exist in nearby Ross, Ridley, and Willow lakes. Loons are declining in Washington due to loss of low-elevation lake habitat and associated human disturbances (Richardson et al. 2000). While the loss of habitat at Hozomeen Lake is unlikely to affect the overall population of common loons, at the local level, loons would be displaced from Hozomeen Lake and either would choose an adjacent area to nest or would discontinue to nest in the North Cascades Complex. Therefore, under alternative C, common loons nesting at Hozomeen Lake would incur minor to moderate impacts.

Cumulative Impacts

Cumulative impacts under alternative C would be similar to those described for alternative A but with substantially reduced impacts on amphibians and native fish from reductions in fish densities and/or removal of reproducing nonnative fish in the North Cascades Complex.

Overall, the impacts associated with other projects, uses, and actions occurring in the region (as described under alternative A) added to the impacts predicted under alternative C, may affect, and are likely to adversely affect certain special status species in the region on a cumulative basis. Actions under alternative C would provide beneficial effects from the reduction of nonnative fish species, which would help limit the extent of cumulative impacts on native fisheries. However, the adverse impacts from development, water pollution, and other projects would cumulatively result in adverse impacts on many special status species. In most cases, an accurate determination of the magnitude of cumulative impacts on special status species cannot be made because available information and research on species' biology, status, and distribution is insufficient. Additional research and population monitoring of special status species that would be affected by the alternatives in this plan/EIS, combined with research completed in the region, would help to better determine cumulative impacts.

Conclusion

Fixed-wing aircraft noise and human disturbance associated with periodic fish-stocking activities under alternative C would have a range of short-term negligible to minor effects on some special status wildlife species but would be reduced from the effects that would occur under alternatives A and B. Short-term impacts related to lake treatments to remove fish would be minor, mostly due to noise from helicopters transporting lake treatment equipment and human disturbance during treatment activities. The use of the chemical, antimycin, to remove fish is not known to have adverse impacts on amphibians. There would be long-term beneficial effects on some aquatic species because most high-

density reproducing populations of fish would be replaced with low-density nonreproducing stocked fish.

Based on the available information, alternative C would have ***no adverse effects on federally listed species*** from fish stocking or lake treatments to remove fish. Regarding ***federally listed species:***

> **23 species may be affected but are not likely to be adversely affected** (American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, little willow flycatcher, marbled murrelet, Northern goshawk, Northern spotted owl, olive-sided flycatcher, Pacific fisher, Yuma myotis, long-eared bat, bald eagle, harlequin duck, Cascades frog, Columbia spotted frog, northern red-legged frog, Western toad, bull trout, Chinook salmon, Coho salmon, and westslope cutthroat trout).
>
> **1 species would incur no effect** (tailed frog).

Regarding ***state-listed species that are not federally listed***, 6 species would incur short-term negligible to minor adverse impacts from noise related to stocking and lake treatment activities, and the common loon would incur long-term minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake.

Cumulative impacts on each special status species from projects or actions occurring throughout the region would be adverse; however, alternative C would contribute only a small increment to overall cumulative impacts.

Impairment of special status wildlife species across the study area would not occur under alternative C.

Alternative D
91 lakes would be fishless

ALTERNATIVE D: 91 LAKES WOULD BE FISHLESS

The emphasis of this alternative would be to either maintain as fishless or eliminate fish from 62 of the 91 mountain lakes in the study area. All 91 lakes would eventually be unavailable for fishing as management actions are completed over time.

The "Alternatives" chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the "Alternatives" chapter and appendix E.

Impacts of Proposed Lake Treatment Methods on Special Status Wildlife Species

Similar to other alternatives, alternative D may affect, but is not likely to adversely affect, any of the following 11 species because these species either do not depend on lake resources, or only eat fish opportunistically, or would not be disturbed by activities associated with lake treatment.

American Peregrine Falcon federal species of concern, state endangered

California Wolverine federal species of concern, state candidate

Canada Lynx federal threatened, state threatened

Gray Wolf federal endangered, state endangered

Grizzly Bear federal threatened, state endangered

Pacific Fisher federal species of concern, state endangered

Marbled Murrelet federal threatened, state threatened

Little Willow Flycatcher federal species of concern

Northern Goshawk federal species of concern, state candidate

Northern Spotted Owl federal threatened, state endangered

Olive-sided Flycatcher federal species of concern

The following 13 listed species are known to be present in the aquatic habitats of the 91 lakes or the adjacent habitats. The impacts on each species from alternative D are discussed below.

Yuma Myotis (Federal Species of Concern). Similar to alternative A, Yuma myotis may be affected, but are unlikely to be adversely affected, by actions under alternative D. The species may experience a minimal amount of stress if lake treatment activities occur near a diurnal (daytime) roost.

Long-eared Myotis (Federal Species of Concern). Similar to alternative A, Long-eared myotis may be affected, but are unlikely to be adversely affected, by actions under alternative D. The species may experience a minimal amount of stress if lake treatment activities occur near a diurnal (daytime) roost.

Bald Eagle (Federal Threatened). Similar to alternative A, alternative D may affect but is not likely to adversely affect bald eagles because they only rarely, if ever, use the high-elevation lakes in the North Cascades Complex to forage or roost.

Harlequin Duck (Federal Species of Concern). Similar to alternative A, implementation of alternative D, may affect, but is unlikely to adversely affect harlequin ducks through short-term, minor, and infrequent noise impacts from lake treatment activities.

Cascades Frog (Federal Species of Concern). Cascades frogs have been documented in two ponds and one stream location in the Bridge Creek drainage (Bury et al. 2000). The species seems to be absent from lakes stocked with fish, and it is unknown if this absence is due to past predation from stocked trout or a preference for shallower waters. Removal of stocked fish from all lakes in the North Cascades Complex under alternative D would not affect Cascades frogs.

Removal of fish in all lakes under alternative D would benefit Cascades frogs as this unnatural source of predation would be eliminated.

Columbia Spotted Frog (Federal Species of Concern, State Candidate Species). Under alternative D, adverse impacts on Columbia spotted frogs would be less than other alternatives. Fish would eventually be removed from lakes in the study area, resulting in long-term benefits to the frog. Lake treatment actions proposed under alternative D may affect, but are unlikely to adversely affect, Columbia spotted frogs.

Northern Red-Legged Frog (Federal Species Of Concern). Northern red-legged frogs would incur long-term beneficial effects under alternative D, and adverse impacts on the species would be minimal and restricted to lake treatment activities to remove fish from study area lakes. Northern red-legged frogs may be affected, but are unlikely to be adversely affected, from implementation of alternative D.

Tailed Frog (Federal Species of Concern). Tadpole and adult tailed frogs have been documented in the outlets of six lakes in the North Cascades Complex, including Upper Bouck and Nert lakes (Liss et al. 1995; Bury et al. 2000), which are currently stocked. The lakes would no longer be stocked under alternative D and would eventually become fishless. Some populations of tailed frogs have evolved in stream environments with fish predation (NPS, R. Glesne, pers. comm., 2003). In the North Cascades Complex, many populations are found in high-gradient tributaries that are inaccessible to fish. Under alternative D, threats to tailed frogs from predatory fish would cease. Removal of fish in Upper Bouck and Nert lakes would occur simply through discontinued stocking, and therefore, alternative D would have no impact on tailed frogs in the North Cascades Complex.

Western Toad (Federal Species of Concern, State Candidate Species). Impacts on Western toads from lake treatment would be similar to those discussed in alternatives B and C and would be limited to localized disturbances from human presence and habitat trampling. Western toads may be affected, but are unlikely to be adversely affected, by actions under alternative D. Western toads would benefit from elimination of fish in study area lakes.

Bull Trout (Federal Threatened). Bull trout may be affected, but are unlikely to be adversely affected, by actions under alternative D. The long-term process of fish removal would eventually eliminate any future threats to bull trout inhabiting downstream basins connected to high mountain lakes—a beneficial effect.

Chinook Salmon (Federal Threatened). Alternative D would provide long-term beneficial effects on Chinook salmon because most lakes would be treated for fish removal and no lakes would be stocked. As with other native fish species, Chinook salmon may be affected, but are unlikely to be adversely affected, by actions under alternative D. The long-term process of fish removal would eventually eliminate threats to Chinook salmon inhabiting downstream basins connected to high mountain lakes.

Coho Salmon (Federal Candidate Species, State Candidate Species). Alternative D would provide long-term beneficial effects on Coho salmon because most lakes would be treated for fish removal and no lakes would be stocked. As with other native fish species, Coho salmon may be affected, but are unlikely to be adversely affected, by actions under alternative D. The long-term process of fish removal would eventually eliminate threats to Coho salmon inhabiting downstream basins connected to high mountain lakes.

Westslope Cutthroat Trout (Federal Species of Concern). As with other native fish species, westslope cutthroat trout may be affected, but are unlikely to be adversely affected, by actions under alternative D. The long-term process of fish removal or reduction would eventually greatly reduce or eliminate threats to native fish inhabiting downstream basins connected to high mountain lakes—a beneficial effect.

State Listed and Other Special Status Wildlife Species. Under alternative D, six species (black-backed woodpecker, golden eagle, Lewis' woodpecker, merlin, pileated woodpecker, and Vaux's swift) may experience negligible to minor adverse impacts from lake treatment actions. Noise impacts from helicopters transporting lake treatment equipment or human presence may temporarily flush individuals of these state candidate species if they are near a lake when treatment activities are occurring, but this would not result in any detrimental impacts on these wildlife species.

The common loon (Washington State sensitive species) may be adversely affected under alternative D because stocked fish would be removed from Hozomeen Lake. Impacts would be the same as described for alternative B, which would be minor to moderate impacts on the pair of breeding loons that has nested at Hozomeen Lake since at least 1971. Adequate fish resources to support a family of loons may exist in nearby Ross, Ridley, and Willow lakes. Loons are declining in Washington due to loss of low-elevation lake habitat and associated human disturbances (Richardson et al. 2000). While the loss of habitat at Hozomeen Lake is unlikely to affect the overall population of common loons, at the local level, loons would be displaced from Hozomeen Lake and either would choose an adjacent area to nest or would discontinue to nest in the North Cascades Complex.

Cumulative Impacts

Cumulative impacts resulting from implementation of alternative D would be similar to those described for alternative A, but with extremely reduced effects to amphibians and native fish because of reduced fish densities and/or removal of reproducing nonnative fish in the North Cascades Complex.

Overall, the impacts associated with other projects, uses, and actions occurring in the region (as described under alternative A), added to the impacts predicted under alternative D, may affect, and are likely to adversely affect, certain special status species in the region on a cumulative basis. Actions under alternative D would provide beneficial effects from the reduction of nonnative fish species, which would help limit the extent of cumulative impacts to native fisheries. Cumulatively, the adverse impacts from development, water pollution, and other projects would adversely affect many special status species. In most cases, an accurate determination of the magnitude of cumulative impacts on special status species cannot be made because available information and research on species' biology, status, and distribution is insufficient. Additional research and population monitoring of special status species that would be affected by alternatives in this plan/EIS, combined with research completed in the region, would help to better determine cumulative impacts.

Conclusion

All fish stocking would be discontinued under alternative D. Short-term impacts related to lake treatments to remove fish would be minor, mostly due to noise from helicopters transporting lake treatment equipment and human disturbance during treatment activities. The use of the chemical, antimycin, to remove fish is not known to have adverse impacts on amphibians.

Based on the available information, alternative D would have ***no adverse effects on federally listed species*** from lake treatments to remove fish. Regarding ***federally listed species:***

> **22 species may be affected but are not likely to be adversely affected** (American peregrine falcon, California wolverine, Canada lynx, gray wolf, grizzly bear, little willow flycatcher, marbled murrelet, Northern goshawk, Northern spotted owl, olive-sided flycatcher, Pacific fisher, Yuma myotis, long-eared bat, bald eagle, harlequin duck, Cascades frog, Columbia spotted frog, northern red-legged frog, Western toad, bull trout, Chinook salmon, Coho salmon, and westslope cutthroat trout).
>
> **2 species would incur no effect** (Cascades frog and tailed frog).

Regarding ***state-listed species that are not federally listed***, 6 species would incur negligible to minor adverse impacts from noise related to fish removal activities, and the common loon would incur minor to moderate adverse impacts due to the removal of its primary food source from Hozomeen Lake.

Cumulative impacts on each special status species from projects or actions occurring throughout the region would be adverse; however, alternative D would contribute only a small increment to overall cumulative impacts.

Impairment of special status wildlife species across the study area would not occur under alternative D.

METHODOLOGY AND ASSUMPTIONS FOR SPECIAL STATUS PLANT SPECIES

Shoreline vegetation around lakes (riparian zones) may be sensitive to trampling by humans or stock (horses, mules, llamas). Many state special status plant species are expected to occur in riparian areas, although no surveys have been conducted to ascertain the presence or absence of these species at specific lakes (NPS, M. Bivin, pers. comm., 2004). In those lakes having riparian areas that include marshes, wet meadows, bogs, seeps, stream edges, and swamps, the probability of having special plant species is higher. Potential impacts on state special status plants were estimated utilizing a methodology similar to that used in the "Vegetation" section in this chapter. Three factors were considered in the analysis: vegetation type, presence or absence of fish in a lake, and accessibility of a lake to anglers.

VEGETATION TYPE

The general type of vegetation found at the shoreline was used as a proxy for the presence of special status species because no surveys to determine which special status plant species are present at each lake have been conducted. For example, shorelines that are dominated by bedrock, talus, and/or snow are assumed to have less habitat for sensitive plant species. Because the vast majority of the state-listed special status plant species grow in areas classified as having meadow or shrub cover (see appendix M), there may be a greater likelihood that lakes with high percentages of these potentially sensitive cover types would face more severe impacts from angler use than those with less sensitive cover types (forest and bare). Analysis methods are qualitative and based on analysis of cover types from aerial photographs (this is described in the "Vegetation" section of the "Affected Environment" chapter). Because the estimates of cover types have not been checked through ground surveys, information about the actual communities surrounding the lakes is lacking; therefore, in order to assess the potential impacts of the alternatives presented under this plan/EIS, it was necessary to use these unverified cover estimates in this analysis.

PRESENCE OR ABSENCE OF FISH

Lakes that are not stocked are not likely to be visited for the purpose of fishing, and impacts caused by anglers at these lakes are expected to be negligible.

ACCESSIBILITY OF THE LAKES TO ANGLERS

Hendee et al. (1977, p. 10) found that the "ease of access, reflected by the distance and elevation gain to the lake, seemed to be directly related to the amount of use." Trail access to the lake also influences the amount of visitation a lake receives. Most anglers prefer lakes with direct trail access, although some anglers prefer more remote and inaccessible lakes (WDFW, B. Pfeifer, pers. comm., 2004; C. Fowler, memorandum, 2003).

The number of visitors, as well as the activities in which those visitors participate, can influence the degree to which vegetation is impacted. Average annual backcountry overnight use was estimated based on backcountry permit data from 1999 to 2002, which indicated that the average annual backcountry overnight use for all camps and cross-country zones near the 91 study area lakes was approximately 4,035 visitors per season (see the "Fishing" section under "Visitor Use and Experience" in the "Affected Environment" chapter and also "Map 2" and "Map 2 Table" located in the envelope that accompanied this plan/EIS). Analysis of backcountry permit data for the 2003 season (NPS 2003C)

indicates that approximately 10.5% of all overnight visitors to camps and cross-country zones intended to fish. Taking into account incomplete sampling due to dispersed access, highly variable and broad time of entry and departure, and purposeful or inadvertent avoidance of backcountry permit registration, a reasonable estimate of annual angling use of the study area lakes would be about 1,000 people per year. The day-use visitor survey performed in 2003 indicates that about 75 of the 1,432 day-use visitors were engaged in fishing at the study area lakes (see table 25 in the "Affected Environment" chapter). More information on visitor use would allow for a more accurate assessment of the impacts that anglers have on high mountain lakes. For the purpose of analyzing impacts on special status plant species, three levels of visitor use were defined.

Low: 0 to 34 visitors of which 0 to 4 were estimated to be anglers

Medium: 35 to 99 visitors of which 4 to 10 were estimated to be anglers

High: 100 to 450 visitors of which 11 to 47 were estimated to be anglers

It is important to reiterate that impacts on special status plant species are unknown, and even very light visitor or angler use at a given lake (see the "Map 2 Table") would result in major localized impacts on a particular species. This is because any trampling of even a very small population of a rare plant has the potential to have a major impact on the species; however, their rarity may also decrease the likelihood of anglers coming into contact with the plants and may serve to protect localized pockets of a plant species from impacts associated with fishing. Without plant surveys or visitor use information, the impact analysis must be based on the assumptions stated above. Actions that can be taken to reduce impacts include surveys and subsequent monitoring of indicator or rare plants at lakes before management actions are implemented, erecting signs and fencing, relocating (or even closing) trail access, and establishing other important mitigation measures.

Beyond the loss of plants through trampling, angler use may cause indirect effects such as erosion and sedimentation, alteration of plant communities, and alteration of food and nutrient inputs to surrounding lakes and creeks. In some cases, bare ground may be exposed leading to soil erosion in subalpine and alpine areas where natural recovery is difficult, and restoration efforts require years of work. Additionally, trampling may lead to changes in site hydrology, which may exclude sensitive wetland species from impacted sites. Due to lack of data for both trail and off-trail lake access by anglers, it was not possible to assess the impact anglers have non-lakeshore communities that visitors travel through to reach the lakes.

FEDERALLY LISTED PLANTS

No federally listed plant species or species proposed for listing occur in the North Cascades Complex, therefore, none of the activities described in any of the alternatives would affect federally listed plant species.

IMPACT THRESHOLD DEFINITIONS FOR STATE LISTED SPECIAL STATUS PLANT SPECIES

The following thresholds were used to evaluate the degree of impact from fishery management activities on state listed special status plant species:

Negligible. Impacts would have no measurable or perceptible changes in plant community size, integrity, or continuity.

Minor. Impacts would be measurable or perceptible but would be localized within a relatively small area. The overall viability of the plant community would not be affected and, if left alone, would recover.

Moderate. Impacts would cause a change in the plant community (such as its abundance, distributions, quantity, or quality); however, the impact would remain localized.

Major. Impacts on the plant community would be substantial, highly noticeable, and permanent.

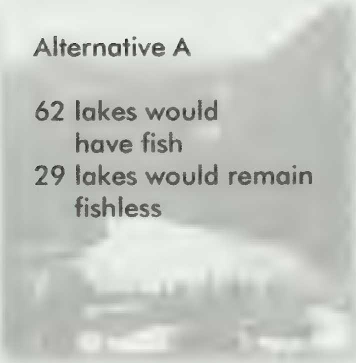
Impairment. The action would contribute substantially to the deterioration of special status plant species in the North Cascades Complex to the extent that the special status plants would no longer function within a natural system. In addition, these adverse major impacts on the North Cascades Complex's resources and values would

> contribute to deterioration of special status plant resources and values to the extent that the purpose of the North Cascades Complex would not be fulfilled as established in its enabling legislation
>
> affect resources key to the natural or cultural integrity or opportunities for enjoyment in the North Cascades Complex
>
> affect the resource whose conservation is identified as a goal in the *General Management Plan* (NPS 1988b) or other planning documents for the North Cascades Complex

IMPACTS OF THE ALTERNATIVES ON SPECIAL STATUS PLANT SPECIES

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A (no action) would continue existing management practices in the 91 lakes in the study area. The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.



Alternative A

62 lakes would have fish
29 lakes would remain fishless

No federally listed plant species occur in the North Cascades Complex. State-listed special status plant species occur in the North Cascades Complex (see appendix C, table C-2), although no surveys have been undertaken to determine the presence or absence of these species at specific lakes. Therefore, it is unknown whether any particular species exists at a given lake. Appendix C provides an overview of state of Washington special status plant species and potential habitats. More than half of the species listed in this appendix may occur as shoreline vegetation including marshes, wet meadows, bogs, seeps, stream edges, and swamps. Those lakes with a higher percent ground cover of meadow (see appendix M) are more likely to provide habitat for these species, and generally, the likelihood of impact from trampling would be higher. In addition, low woody species with brittle stems (e.g., *Salix* spp.) and tree seedlings are resistant to low levels of trampling but recover slowly following damage at high levels of trampling (Cole and Trull 1992). Lakes with a higher percentage of shrub ground cover are more likely to provide habitat for these species and may also be impacted at higher levels than areas with no cover (bare).

Impacts of Current Fish Stocking on State-Listed Special Status Plant Species

Using methodology similar to that described for the "Vegetation" section in this chapter, of the 62 lakes available for fishing under alternative A, 52 are classified as having meadow and 7 are classified as having shrub cover in the shoreline vegetation (see appendix M). For the lakes with these types of shoreline cover, and that experience low visitor use, fish stocking has and may continue to have only negligible to minor adverse impacts on any special status plant species. For the remainder of lakes receiving medium to high visitor use (visitor use levels can be found on "Map 2 Table"), continued fish stocking would result in short-term negligible to major adverse impacts on any state special status species that might grow in the shoreline environment. For the lakes with no shoreline classified as meadow or shrub, adverse impacts on any state special status species may be negligible to moderate. It was not possible to determine if any of these communities include any state-listed special status species, which is why the range of potential impacts is so broad.

Impacts of Lake Treatment Methods on State-Listed Special Status Plant Species

No lakes are proposed for fish removal under alternative A; therefore, impacts would be negligible.

Cumulative Impacts

Visitor use is expected to follow the same patterns that it has for several years. Trampling by horses, mules, or llamas may also occur in areas around lakes. This trampling, combined with angler use, other visitor use, and fish stocking, is likely to result in minor to moderate cumulative impacts at some lakes and moderate to major at others, depending on the intensity of use and location of sensitive plant species.

Conclusion

Fish-stocking activities at lakes with shoreline meadow or shrub vegetation would have short-term negligible to minor adverse impacts on any special status plants in the shoreline areas of lakes in zones or near camps with low visitor use. Stocking activities at lakes in zones or near camps with medium to high visitation would result in short-term negligible to major adverse impacts on any special status plants.

No lakes are treated for fish removal under alternative A.

Trampling by stock (horses, mules, llamas) and visitors (anglers and other visitors) would likely result in minor to moderate cumulative impacts at some lakes and moderate to major at others, depending on the intensity of use and location of sensitive plants.

Impairment of special status plant species across the study area would not occur under alternative A.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

The goal of this alternative is to eliminate or reduce reproducing fish from select lakes in the study area. Forty-two lakes would potentially be available for fishing. Of these, 29 lakes would continue to have fish, and 13 lakes would be evaluated for restocking. Twenty lakes would revert to fishless conditions, and the 29 currently fishless lakes would remain fishless. The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E. For additional information on shoreline vegetation, see the "Vegetation" section in this chapter and appendix M.

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

Of the 42 lakes that may potentially be available for fishing (refer to table 10), 35 have some amount of meadow shoreline vegetation. Twenty-two of the 35 lakes are within cross-country zones or near camps that experience medium or high visitor use, and impacts may remain negligible to moderate over time. The other 13 lakes that have meadow vegetation, and may potentially be available for fishing under this alternative, have fewer than 34 annual visitors in a given year and very little trail access. Impacts on state-listed special status plant species at these 13 lakes may be negligible or minor.

Impacts of Proposed Fish Stocking on State-Listed Special Status Plant Species

Alternative B proposes the discontinuation of stocking or removal of fish in 44 lakes, as well as the restocking of 24 of those lakes after evaluation or monitoring (refer to tables 5 and 10 in the "Alternatives" chapter). Twenty-one of the 24 lakes that may be restocked have some meadow vegetation around the shore that is vulnerable to trampling (3 of the 24 lakes have no meadow vegetation at present). Should the 21 lakes be restocked, impacts would not change from what they are now. Fourteen of the 21 lakes are within cross-country zones or near camps that have medium or high levels of visitor use, with the possibility of short-term negligible to moderate adverse impacts on meadow vegetation. Seven of the 21 lakes that may be restocked are within zones or near camps that have low visitor use and may experience negligible or minor impacts on meadow riparian vegetation. If the lakes are not restocked, negligible to moderate beneficial effects on meadow vegetation may occur.

Impacts of Proposed Lake Treatment Methods on State-Listed Special Status Plant Species

The use of mechanical or chemical method to remove fish would involve trampling of riparian or wetland vegetation, but mitigation measures described in appendix I would be implemented; those include maximizing the use of boats or wading in the lake to avoid sensitive lakeside vegetation. With mitigation measures in place, the impact of fish removal activities on state-listed plants would be negligible to minor.

Natural Methods. A total of 12 lakes under alternative B would receive natural treatment to remove fish. Natural treatment is the cessation of stocking, which over time would mean the die-off of all fish in a lake. During this period of die-off, fishing and any associated trampling would continue with impacts as described above; however, a similar and permanent benefit from the eventual elimination of all angler-related foot traffic would eventually occur.

Mechanical Methods. Mechanical methods would be used to treat up to 8 lakes. Impacts on state special status plant species would likely be short term and range from negligible to minor if personnel involved in removing fish are trained to avoid state-listed special status plant species.

Chemical Method. Chemical treatment is proposed for 19 lakes. There would be a short-term negligible impact on state special status plant species from human

activity in an area during chemical removal of reproducing fish, but the proposed chemicals should have no effect on plant species.

Cumulative Impacts

Visitor use beyond angling is expected to follow the same patterns that it has for several years. Trampling by horses, mules, or llamas may also occur in areas around lakes. This trampling, combined with angler use, other visitor use, and lake treatment and fish stocking activities, would result in negligible cumulative impacts on state-listed special status plant species at some lakes and moderate or major cumulative impacts at other lakes, depending on the intensity of use and location of sensitive plants.

Conclusion

Fewer lakes would be stocked under alternative B. Trampling during stocking activities may result in short-term negligible to moderate adverse impacts on any special status plants that may be present in the shoreline of lakes that are in cross-country zones or near camps that receive medium to high use, and negligible to minor adverse impacts at lakes in zones or near camps that have low visitor use. There would long-term beneficial effects on special status plant species at lakes where stocking would not occur.

Select lakes would be treated for fish removal under alternative B. Trampling during mechanical and chemical lake treatment activities may result in short-term negligible to minor adverse impacts on any special status plants that may be present in the shoreline of lakes that are in cross-country zones or near camps that receive medium to high visitor use, and negligible to minor adverse impacts at lakes in zones or near camps that have low visitor use.

Trampling by stock (horses, mules, llamas) and visitors (anglers and other visitors) would likely result in negligible cumulative impacts at some lakes and moderate to major at others depending on the intensity of use and location of sensitive plants.

Impairment of special status plant species across the study area would not occur under alternative B.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

Under alternative C, 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish and 2 lakes would be evaluated for restocking. Eleven other lakes in the national recreation areas would remain fishless or be returned to fishless conditions. The remaining 69 lakes (which are in the national park) would be returned to their natural fishless conditions or would remain fishless.

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

The “Alternatives” chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the “Alternatives” chapter and appendix E.

Impacts of Proposed Fish Stocking on State-Listed Special Status Plant Species

There would potentially be 80 lakes unavailable for fishing in alternative C, as opposed to 29 in alternative A. This alternative would benefit state-listed plant species.

Currently, of the 9 lakes that would remain available for fishing, 3 are classified as having at least some meadow, wetland, or shrub cover in its shoreline vegetation and are classified as high- to moderate-use areas. Impacts from sport fishing may be negligible to major at these lakes. The remaining lakes experience low visitor use and/or have no shoreline classified as meadow, wetland, or shrub. These lakes are more likely to experience negligible to moderate impacts on state-listed plant species.

Impacts of Proposed Lake Treatment Methods on State-Listed Special Status Plant Species

Fifty-five lakes are proposed for fish removal under alternative C.

Natural Methods. Twenty-one lakes would be treated with natural methods to remove fish. Natural treatment is usually the cessation of stocking, which over time would mean the die-off of all fish in a lake. During this period of die-off, angling and any associated trampling would continue with impacts as described above; however, a similar and permanent benefit from the eventual elimination of all angler-related foot traffic would eventually occur.

Mechanical Methods. Mechanical treatment is proposed for up to 10 lakes. Impacts on state special status plant species would be short-term negligible to minor if personnel involved in removing fish were trained to avoid state-listed special status plant species.

Chemical Method. A total of 25 lakes are proposed for chemical treatment. There would be a short-term negligible impact on state-listed species from human activity associated with chemical removal of reproducing fish, but the proposed chemicals should have no effect on plant species.

Cumulative Impacts

Visitor use is expected to follow the same patterns that it has for several years. Trampling by horses, mules, or llamas may also occur in areas around lakes. This trampling, combined with decreases in angler use, would result in negligible to minor cumulative impacts, depending on the intensity of use and location of sensitive plants. These impacts over the long term would be reduced to a negligible level as lake treatments are completed, although more serious impacts resulting from non-angler visitor use would still be possible.

Conclusion

Considerably fewer lakes would be stocked under alternative C than under alternatives A and B. Trampling during stocking activities may result in short-term negligible to moderate adverse impacts on any special status plants that may be present in the shoreline of lakes that are in cross-country zones or near camps that receive medium to high use, and negligible to minor adverse impacts at lakes in zones or near camps that have low visitor use. There would long-term beneficial effects on special status plant species at lakes where stocking would not occur.

A higher number of lakes would be treated for fish removal under alternative C than under alternative B. Trampling during mechanical and chemical lake treatment activities may result in short-term negligible to minor adverse impacts on any special status plants that may be present in the shoreline of lakes that are in cross-country zones or near camps that receive medium to high use, and negligible to minor adverse impacts at lakes in zones or near camps that have low visitor use.

Trampling by stock (horses, mules, llamas) and visitors (anglers and other visitors) would likely result in negligible to minor cumulative impacts depending on the intensity of use and location of sensitive plants. These impacts over the long term would be reduced to a negligible level as lake treatments are completed.

Impairment of special status plant species across the study area would not occur under alternative C.

Alternative D: 91 Lakes Would Be Fishless

Under alternative D, all 91 lakes would be fishless.

The “Alternatives” chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the “Alternatives” chapter and appendix E.

Alternative D

91 lakes would be fishless

All lakes potentially would be unavailable for fishing in alternative D, as opposed to 62 in alternative A; therefore, this alternative is most likely to benefit state special status plant species because sport fishing would eventually be eliminated in the study area lakes.

Under this alternative, there would be a widespread beneficial effect.

Impacts of Proposed Fish Stocking on State-Listed Special Status Plant Species

Stocking would not occur in any of the study area lakes.

Impacts of Proposed Lake Treatment Methods on State-Listed Special Status Plant Species

Sixty-two lakes are proposed for fish removal under alternative D.

Natural Methods. A total of 26 lakes would receive natural treatment to remove fish. Natural treatment is usually the cessation of stocking, which over time would mean the die-off of all fish in a lake. During this period of die-off, angling and any associated trampling would continue with impacts as described above; however, a similar and permanent benefit from the eventual elimination of all angler-related foot traffic would eventually occur.

Mechanical Methods. Up to 11 lakes are proposed for mechanical treatment. Impacts on state special status plant species would be short-term negligible to minor if personnel involved in removing fish were trained to avoid state-listed special status plant species.

Chemical Method. A total of 25 lakes are proposed for chemical treatment. There may be a short-term negligible impact on state-listed species from human activity associated with chemical removal of reproducing fish, although the proposed chemicals themselves should have no effect on plant species.

Cumulative Impacts

Visitor use is expected to follow the same patterns that it has for several years. Trampling by horses, mules, or llamas may also occur in areas around lakes. Decreases in angler use may offset some of these continuing impacts, but the possibility of negligible to minor cumulative impacts on state special status plant species from activities not related to angling would remain. These impacts over the long term would be reduced to a negligible level as lake treatments are completed.

Conclusion

Fish stocking would not occur under alternative D, which would result in long-term beneficial effects on special status plant species.

Mechanical and chemical lake treatment activities to remove fish would result in short-term negligible to minor adverse impacts.

Trampling by stock (horses, mules, llamas) and visitors would likely result in negligible to minor cumulative impacts depending on the intensity of use and location of sensitive plants. These impacts over the long term would be reduced to a negligible level as lake treatments are completed.

Impairment of special status plant species across the study area would not occur under alternative D.

VEGETATION

GUIDING REGULATIONS AND POLICIES

The *General Management Plan* (NPS 1988b) includes the following management objectives that are relevant to overall natural resources for the North Cascades Complex, including vegetation:

> To increase knowledge and understanding of the interrelationships of the natural processes, and of methods for implementation of appropriate actions.
>
> To preserve, maintain, or restore, where feasible, the primary natural resources and those ecological relationships and processes.
>
> To manage the natural resources as an integral part of a regional ecosystem.
>
> To provide opportunity for research in as natural a system as possible.

The *Strategic Plan* (NPS 2000a) also includes goals for preserving park resources that are consistent with the goals and objectives of this analysis. Mission Goal I.a. states, "Natural and cultural resources and associated values of the North Cascades National Park Service Complex are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context."

Servicewide NPS regulations such as the *Organic Act of 1916* and the *NPS Management Policies* (NPS 2001a) also direct parks to provide for the protection of park resources, including shoreline vegetation. The *NPS Management Policies* state that "Where human activities or structures have altered the nature or rate of natural shoreline processes, the Service will, in consultation with appropriate state and federal agencies, investigate alternatives for mitigating the effects of such activities or structures and for restoring natural conditions."

METHODOLOGY AND ASSUMPTIONS FOR VEGETATION

A primary concern identified in the public scoping process was that of adverse effects of fish stocking on native plant species near mountain lakes. All visitors to the mountain lakes in the North Cascades Complex may impact shoreline vegetation through (1) trampling by humans or stock (horses, mules, or llamas); (2) activities associated with camping; (3) activities associated with fishing; and (4) indirect impacts, which can include increased erosion and sedimentation rates, depending on the particular shoreline cover surrounding a lake. These impacts may be long term because vegetation grows slowly in the short growing season of the mountains, and soil compaction or erosion makes regrowth of vegetation even more difficult.

SOURCES OF INFORMATION

In order to assess impacts associated with fish stocking and angling, it was necessary to consider (1) which plant communities are found in areas likely to be affected by fishery management actions described in the alternatives, and (2) effects of angling on different plant communities above and beyond effects of other visitors.

Plant communities around the shoreline of study area lakes (see appendix M) were described using aerial photos. Lake perimeter distance was estimated by on-screen digitizing of shoreline distance using 1:12000 black and white Digital Orthophoto Quads. Lakeshore vegetation cover types were estimated from 1:12000 color photos (false color infrared) analyzed in stereo (3-dimensional). Cover-type values are percentages of the total perimeter for each lake within an 82-foot buffer defined as the riparian zone. The photographs were taken in August 1998 (NPS 2003a). It is important to note that the aerial photos only offer large-scale estimates of cover and have not been checked through ground observations; therefore, precise information about the actual vegetation communities surrounding the lakes is lacking. Impact predictions are characterized as ranges (for example, minor to moderate) primarily for this reason.

In addition, the data available on lake visitation by anglers versus all other recreational users is incomplete and sometimes contradictory. In a study of high mountain lakes conducted by Hendee et al. (1977), the researchers concluded that "manipulating the fishery to modify visitation at high lakes is, at best, a partial solution" because other visitors would continue to affect the resources. Many anglers observed and interviewed during the course of the study cited reasons other than fishing as their primary motivation for visiting the lakes, which suggests that their use patterns may not change as a result of fish removal. On the other hand, research conducted in the late 1980s by Hospodarsky and Brown (1992) suggests that anglers spent three times longer in riparian zones than other user groups. The researchers hypothesized that if time spent in the riparian zone were proportionate to impacts, then anglers would have up to three times as great an impact as hikers (Hospodarsky and Brown 1992). This hypothesis has yet to be tested. It is also important to note that many anglers fish with rafts, which limits trampling of riparian vegetation (WDFW 2001).

Perennating: to survive from one growing season to the next with reduced or arrested growth between seasons.

Scientific literature was consulted to obtain additional information that factors into the impact analysis. Work done by Cole and Trull (1992) shows that both plant stature and location of perennating tissues at or below the ground, influence the ability of vegetation types to resist and recover from trampling. Tall, tough, woody shrubs and grasses that occur in bunches or as turf (for example, *Carex* spp.) were most resistant to damage by trampling. Low, woody species with brittle stems (such as *Phyllodoce* spp.) and tree seedlings resisted low levels of trampling but were sensitive to high levels of trampling. Broad-leaved herbaceous species were most sensitive to the effects of trampling. Species that recovered most quickly following damage were fast-growing herbaceous species or tufted or turf-producing grasses. Woody species, as well as more uncommon broad-leaved species that suffered damage to their regenerative tissues recovered more slowly following damage.

Potential indirect impacts of trampling include increased erosion and sedimentation rates associated with loss of roots and the plants' ability to hold soils and compaction of riparian soils. Reduced lakeshore vegetation may reduce organic matter input, thereby altering patterns of nutrient cycling. Terrestrial insects and other organisms that get into the lake and become prey to aquatic organisms may also be affected indirectly through loss of shoreline vegetation that serves as habitat. There are no data on the levels of indirect impacts anglers may have on lakeshore environments; therefore, it was only possible to describe the impact qualitatively.

Anglers and other visitors traveling cross-country or off trail to reach certain remote lakes would adversely affect vegetation, but there is no available information on the degree of impact or even the vegetative communities where such an impact might take place. The WDFW believes that no conclusions are possible; however, comparative conclusions are common in environmental impact statements. The impact is, therefore, considered a possibility and described qualitatively, but no assessment on the degree of impact is possible.

The trampling of vegetation and creation of social trails are a common problem, especially in subalpine areas. Photo is of Sahale Arm with Doubtful Lake in the background (date unknown).

ASSUMPTIONS

As noted above, the number of visitors, as well as the activities in which those visitors participate, can influence the degree to which vegetation is impacted. Since neither data specific to particular plant communities nor particular impacts of anglers at the 91 study area lakes were available, the potential impact to plant communities around mountain lakes was tied to the fishing potential of a given lake, the level of visitor use in the cross-country zones or established camps near the 91 lakes, and the cover types that are present in the 82-foot riparian zone surrounding the lakes in the study area.

Average annual backcountry use was estimated based on backcountry permit data from 1999 to 2002. The data are not lake specific but based on backcountry overnight use permits issued for cross-country zones or camps located near lakes. Data from the backcountry overnight use permit database for 2003 suggest that anglers comprise about 10.5% of all backcountry overnight visitors to the 91 lakes in the study area (NPS 2003c). Data on day use by anglers was estimated for 7 of the lakes (refer to table 25 in the "Affected Environment" chapter). More information on visitor use would allow for a more accurate assessment of the impacts that anglers have on specific mountain lakes. For the purpose of analyzing the impacts on vegetation, three levels of visitor use were considered (see appendix M for shoreline cover data and "Map 2" and "Map 2 Table" for more information on the average annual overnight visitation at the 91 lakes).

Low:	0 to 34 visitors of which 0 to 4 were estimated to be anglers
Medium:	35 to 99 visitors of which 4 to 10 were estimated to be anglers
High:	100 to 450 visitors of which 11 to 47 were estimated to be anglers

Trail and stock (horses, mules, llamas) access to lakes may result in trampling of vegetation and changes in the hydrology of impacted sites. Although trail and stock access would influence the extent of shoreline impacts to a given lake, it is difficult to identify those lakes that hold an increased interest to anglers; therefore, no assumptions in this regard were considered valid and none were made.

The following assumptions regarding vegetative cover were made based on the aerial surveys described above under "Sources of Information" (appendix M lists the shoreline cover types for the 91 lakes in the study area).

Deciduous: Trees that lose their leaves at the end of the growing season; also called hardwoods.

> Deciduous and/or coniferous trees are dominant in the forest cover type.
>
> Shrub cover type is characterized by the predominance of woody shrubs.
>
> Meadow cover describes areas where forbs and graminoids (grasses) are dominant, but may include low-lying shrubs as well.
>
> Areas that are not vegetated are assigned to the bare cover type and include exposed bedrock, talus slopes, and cliffs (talus slopes may contain plants, but the frequencies at which they occur have not been quantified; therefore, talus slopes are included in the bare cover type [Liss 1995; NPS, M. Bivin, pers. comm., 2004]).

Methods Used to Analyze Impacts

For a given lake, impacts on vegetation were determined using the following methods:

Classifying the type of shoreline surrounding the lake. For example, shorelines that are dominated by bedrock, talus, and/or snow may not be as sensitive to trampling as lakeshores with an abundance of low meadow vegetation or low-lying shrub species that recover slowly following damage. At lakes that have high percentages of potentially sensitive cover types (that is, shrub and meadow types), the vegetation is more likely to face more severe impacts due to angler use than at those lakes with less sensitive cover types (bare of vegetation).

Identifying whether or not the lake provides a fishing opportunity. Evidence suggests that anglers use riparian areas more extensively than other visitors. Lakes with fish are likely to experience a greater impact on riparian community types than fishless lakes. For those fishless lakes that are to remain fishless in all alternatives, the potential impacts on vegetation would be negligible and would resemble other lakes in the park where fishing does not occur.

Identifying those lakes where stock (horses, mules, llamas) have direct access to the shoreline and the lake. Although it is extremely difficult to identify one type of user as the reason for shoreline impacts, lakes such as McAlester Lake are known to have impacts from stock associated with the shoreline vegetation of the lake. If a lake is available for fishing, has stock access, and has a high percentage of cover types that are sensitive to trampling (i.e., huckleberry-heather shrub communities), impacts would be greater than at other lakes that do not have these factors associated with them (refer to table 23 in the "Affected Environment" chapter for lakes accessible by horseback).

Identifying those lakes that are most accessible. Hendee et al. (1977) found that the "ease of access, reflected by the distance and elevation gain to the lake, seemed to be directly related to the amount of use." Trail access to the lake also influences the amount of visitation a lake receives. Most anglers prefer lakes with direct trail access, although some anglers prefer more remote and inaccessible lakes (WDFW, B. Pfeifer, pers. comm., 2004; WDFW, B. Fowler, pers. comm., 2003).

DEFINITIONS OF INTENSITY LEVELS

Negligible. Impacts would have no measurable or perceptible changes in plant community size, integrity, or continuity.

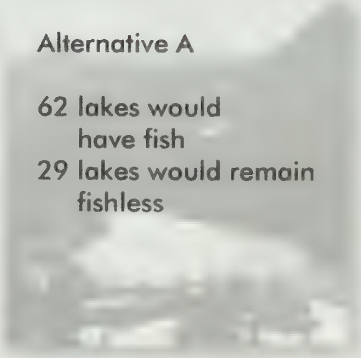
Minor. Impacts would be measurable or perceptible but would be localized within a relatively small area. The overall viability of the plant community would not be affected and, if left alone, would recover.

Moderate. Impacts would cause a change in the plant community (such as abundance, distributions, quantity, or quality); however, the impact would remain localized.

Major. Impacts on the plant community would be substantial, highly noticeable, and permanent.

Impairment. The action would contribute substantially to the deterioration of vegetation in the North Cascades Complex to the extent that vegetation would no longer function as a natural system. In addition, these adverse major impacts on the North Cascades Complex's resources and values would

> contribute to deterioration of these resources to the extent that the North Cascades Complex's purpose would not be fulfilled as established in its enabling legislation
>
> affect resources key to the North Cascades Complex's natural or cultural integrity or opportunities for enjoyment
>
> affect the resource whose conservation is identified as a goal in the *General Management Plan* or other planning documents for the North Cascades Complex



Alternative A

62 lakes would have fish
29 lakes would remain fishless

IMPACTS OF THE ALTERNATIVES ON VEGETATION

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

The current mountain lakes fishery management activities at the North Cascades Complex, which are described in the "Alternatives" chapter, would continue under the no-action alternative. For more information on the 91 lakes, refer to

table 5 and figure 4 in the "Alternatives" chapter, appendix E, appendix M, and "Map 2" and "Map 2 Table" located in the envelope that accompanied this document.

Impacts of Current Fish Stocking on Vegetation (Riparian Vegetation)

A well-used campsite at Stout Lake.

Trampling from visitor use, including hiking, fishing and stock (horses, mules, llamas) use, would continue at current levels or worsen around the shorelines of well-used lakes if alternative A were selected. The degree of these impacts would vary and range from negligible to moderate depending on the factors identified under "Methodology and Assumptions" in this section; these factors include the type and extent of vegetation, access, fishing potential, availability of overnight camping, and stock access. Impacts would be more likely where a lake's shoreline is covered in meadow or wetland vegetation. Of the 62 lakes that would continue to have fish in this alternative, 52 lakes are classified as having from 2% to 76% meadow in the shoreline; cover data is absent for one lake.

Of the 52 lakes that contain fish and have shoreline meadow vegetation, 20 lakes are located in cross-country zones or are near established camps that have low visitor use—continued fish stocking is expected to have only negligible adverse impacts on vegetation at these lakes. Another 19 lakes with shoreline meadow vegetation are in zones or near camps that have a medium level of visitor use—continued fish stocking in these lakes would result in negligible to minor adverse impacts on meadow vegetation. Negligible to moderate adverse impacts on shoreline meadow vegetation would occur at 13 lakes that are in cross-country zones or near camps that receive high visitor use.

The backcountry overnight use permit data are not lake specific but based on backcountry overnight use permits issued for cross-country zones or camps near the 91 lakes in the study area.

These assessments of impacts are broad for several reasons. Because impacts due to anglers alone have not been investigated, it is difficult to determine how continued fish stocking may affect riparian communities. A single angler who spends the majority of the time in meadow or shrub communities would potentially have a significant local impact on sensitive vegetation. Anglers who use rafts and limit the time spent along the shoreline would unlikely have more than a negligible impact on the riparian vegetation of the lakes they visit.

Negligible to moderate adverse impacts would occur at the 7 lakes where shrub communities are present and meadow communities are not. It is not possible to determine if more resistant high-stature shrubs (such as willows) or sensitive low-lying shrubs (such as heather and huckleberry) are dominant at individual lakes, which is why the range of potential impact is broad. Forest cover dominates shoreline at one lake that experiences low visitor use, and thus, fish stocking may have negligible adverse impacts. Forest cover is dominant at 2 lakes that experience high visitor use; the effects of continued fish stocking at these lakes would be negligible to minor and adverse. One lake with fish is classified as having only the bare cover type in the riparian zone, so impacts at this lake would be negligible.

The 29 lakes that are currently fishless experience negligible impacts from fish stocking.

Impacts of Lake Treatment Methods on Vegetation (Riparian Vegetation)

No lakes are currently treated or would be treated for fish removal in the future under alternative A; therefore, impacts would be negligible.

Impacts of Other Mitigation

To reduce effects of visitors (including anglers) on shoreline vegetation and on other visitors' wilderness experience, additional visitor education efforts toward leave-no-trace visits would be instituted. This would decrease the overall adverse impacts to those lakes with an abundance of meadow and shrub cover types depending on the effectiveness of the campaign on the visitors to these lakes.

Cumulative Impacts

Under alternative A, cumulative impacts on shoreline vegetation from other recreationists may be negligible to moderate when added to those from angler use. Although use by anglers and other visitors (including visitors with stock—horses, mules, or llamas) may increase in the future, there is little likelihood that their shoreline activities would affect the overall integrity of the plant community greater than moderate impacts. No projects are proposed or in planning stages that would change the road access to any unit of the North Cascades Complex, and no new trails or trailheads are being considered; consequently, there would be no increase in impacts resulting from new trails to the mountain lakes in the North Cascades Complex.

Conclusion

Fifty-nine of the 62 lakes in the study area where fishing would continue have meadow and/or shrub vegetation. Of these, about 75% have low to medium visitation, and vegetation would experience only negligible impacts. The remaining 25% that have high visitation would continue to experience minor to moderate, long-term, adverse impacts from trampling. Forest shoreline vegetation would generally not be affected more than a negligible or minor level from visitor use, including angling. Cumulative impacts would be negligible to moderate and adverse over the long term.

Impairment of vegetation across the study area would not occur under alternative A.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

Impacts of Proposed Fish Stocking on Vegetation (Riparian Vegetation)

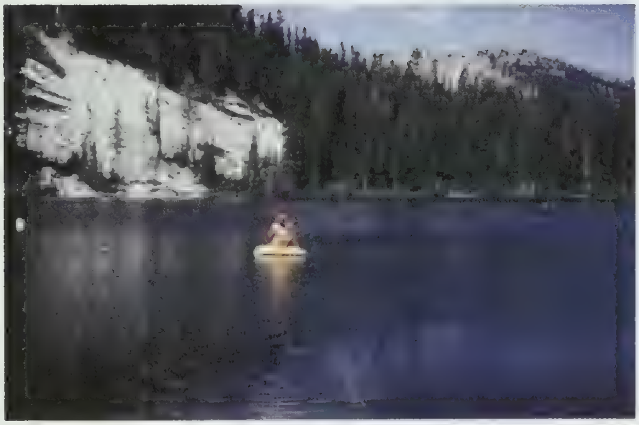
Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

In alternative A, 62 lakes are available for fishing, and of these, 52 have meadow vegetation in the shoreline. Not all of the vegetation is equally vulnerable to trampling by visitors because visitor use, fish stocking practices, and access differ. In alternative B, fewer lakes would be available for fishing, and a new category of management prescriptions, that of monitoring to determine future activities, would be added.

Under alternative B, up to 20 lakes would be permanently returned to fishless conditions. Of these lakes, 16 do have some meadow vegetation, and all would experience negligible to moderate benefits from a reduction in visitor use attributable to fishing. Nine of the lakes are in areas that have medium or high levels of visitor use and/or trails leading to the lakes. Although reducing fishing opportunities at these lakes may benefit riparian vegetation to a greater degree than those where visitor use is low, it is also likely that at least some may experience high levels of use that are unrelated to fishing. In these cases, meadow shoreline vegetation may continue to experience minor or moderate impacts.

As in all alternatives, the 29 currently fishless lakes would remain fishless, with continuing possible negligible impacts from past stocking and trampling and loss of lakeside vegetation.



All reproducing fish would be removed from McAlester Lake, and monitoring would help determine whether to restock.

Alternative B proposes the discontinuation of stocking or removal of fish in 44 lakes, as well as the restocking of 24 of those lakes after evaluation or monitoring (refer to tables 5 and 10 in the "Alternatives" chapter). Twenty-one of the 24 lakes that may be restocked have some meadow vegetation around the shore that is vulnerable to trampling (3 of the 24 lakes have no meadow vegetation at present). Should the 21 lakes be restocked, impacts would not change from what they are now. Fourteen of the 21 lakes are within cross-country zones or near camps that have medium or high levels of visitor use, with the possibility of negligible to moderate impacts on meadow vegetation. Seven of the 21 lakes that may be restocked are within zones or near camps that have low visitor use and may experience negligible or minor impacts on meadow riparian vegetation. If the lakes are not restocked, negligible to moderate beneficial effects on meadow vegetation may occur.

Of the 42 lakes that may potentially be available for fishing (refer to table 10), 35 have some amount of meadow shoreline vegetation. Twenty-two of the 35 lakes are within cross-country zones or near camps that experience medium or high visitor use, and impacts may remain negligible to moderate over time. The other 13 lakes that have meadow vegetation, and may potentially be available for fishing under this alternative, have fewer than 34 annual visitors in a given year and very little trail access. Impacts on vegetation at these 13 lakes may be negligible or minor.

Negligible to moderate adverse impacts are expected for the 6 lakes that would continue to have fish or would be restocked and where shrub communities are present and meadow communities are not. It was not possible to determine if more resistant high-stature shrubs (such as willows) or sensitive low-lying shrubs (such as heather and huckleberry) are dominant at individual lakes, which is why the range of potential impact is broad. Forest cover is dominant at 1 lake that experiences high visitor use; the effects of continued fish stocking at this lake may be minor and adverse.

Impacts of Lake Treatment Methods on Vegetation

Natural Methods. Natural methods would be used to remove fish from 12 lakes. Ongoing impacts from sport fishing would continue until fishing is no longer satisfactory to anglers and fish are no longer present, after which time, conditions would likely improve.

Mechanical Methods. Mechanical methods would be used to treat up to 8 lakes. One lake is proposed for spawning habitat exclusion. A 30-foot section of spawning habitat would be covered with rock taken from a nearby talus slope and moved by hand to the lake. Adverse impacts on meadow vegetation from covering vegetation with rock and from trampling would be minor to moderate and short-term. Setting gillnets and using electroshocking equipment would result in some trampling, although mitigation by avoiding vegetation and wading near the shore rather than walking through shoreline vegetation would reduce the impact to negligible or minor and short term.

Chemical Methods. Chemical treatment is proposed for 19 lakes. There would be a negligible impact on vegetation from chemical removal of reproducing trout.

Impacts of Other Mitigation

Impacts of other mitigation would be similar to those under alternative A. Additional signs would be posted in riparian areas that were most heavily used to allow for recovery of vegetation. Furthermore, using an adaptive management approach for lakes to be evaluated would provide an opportunity to monitor the level of impact anglers have on vegetation, and possibly make fishery management decisions based at least in part on the condition of shoreline vegetation at a given lake.

Cumulative Impacts

Cumulative impacts would be similar to alternative A (negligible to moderate, adverse, and long term), although potentially reduced because there would be fewer lakes available for stocking and fishing.

Conclusion

Twenty-nine of the 35 lakes in the study area where fishing would continue have meadow vegetation that is sensitive to trampling. Eleven of the 29 lakes are within cross-country zones or near camps that would continue to experience low visitor use, with resulting negligible to minor adverse impacts. Eighteen of the 29 lakes are within cross-country zones or near camps that would continue to experience medium to high visitor use, and vegetation would experience negligible to moderate impacts. In addition to the 29 lakes that are currently fishless in alternative A, alternative B would return 20 lakes to a fishless condition with possible negligible to moderate benefits to shoreline meadow vegetation over time. Temporary negligible to moderate adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatments would occur, and continued fishing as a means of natural removal would have short-term negligible to moderate adverse impacts. Cumulative impacts would be negligible to moderate, adverse, and long term.

Impairment of vegetation across the study area would not occur under alternative B.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

Impacts of Fish Stocking on Vegetation (Riparian Vegetation)

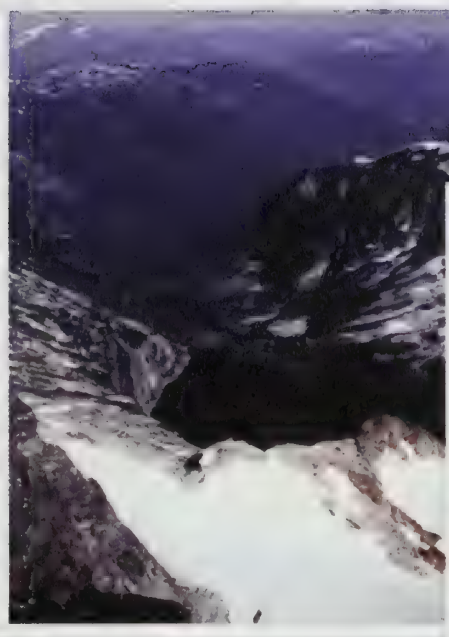
Alternative C

- 9 lakes would have fish
- 80 lakes would be fishless
- 2 lakes would be evaluated for restocking

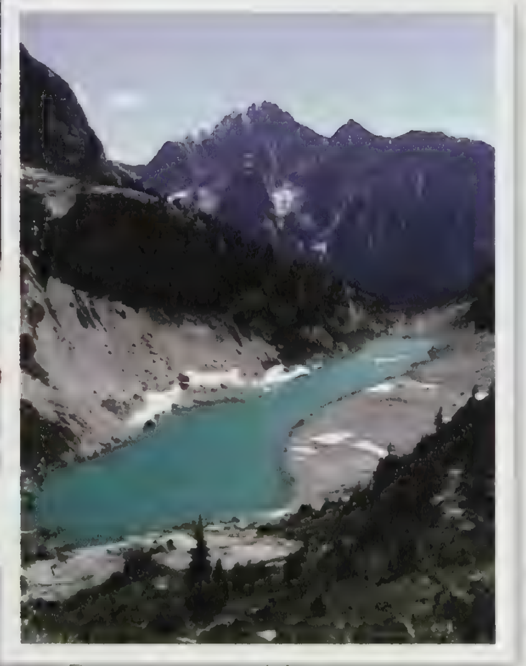
Alternative C proposes an adaptive management framework for 91 lakes, where 11 of the 22 lakes in the Ross Lake and Lake Chelan National Recreation Areas may have fish, and the remaining 69 lakes, which are in the national park, either would remain fishless or be returned to their natural fishless condition. Of the other 11 lakes in the national recreation areas, 3 would remain fishless, 3 would have high-density reproducing fish removed, and stocking would be discontinued in 5 lakes. The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter, appendix E, and "Map 2" and "Map 2 Table" located in the envelope that accompanied this document.

Under alternative C, adverse impacts on riparian zone vegetation would be negligible to moderate in those lakes with an abundance of meadow vegetation, which allows for walking along the shore. All 9 lakes that would continue to have fish have from 20% to 58% meadow in the shoreline. The 2 lakes that would be evaluated for possible future stocking of fish at low densities also have meadow vegetation.

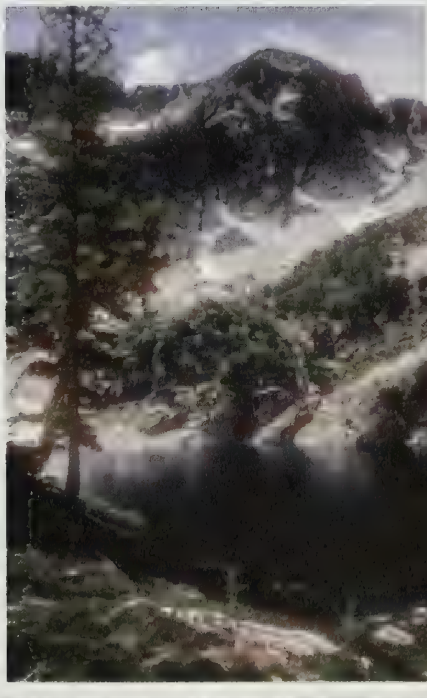
As noted earlier, visitor numbers, trail access, and stock access influence the degree of impact. Of the 9 lakes with meadow vegetation that would be available for continued fishing, 5 are located in cross-country zones or are near camps that have low visitor use and most likely experience negligible impacts in the riparian zone. This would continue under alternative C. None of the 9 lakes are located in zones or are near camps that receive a medium level of visitation. Two of the



Azure Lake



Wild Lake



Pegasus Lake

Despair Lake, Lower

Lakes that are currently fishless would remain fishless under all alternatives.

9 lakes, however, are located in zones or are near camps that experience high visitor use—impacts on meadow vegetation at these 2 lakes may continue to be negligible to moderate. There are 2 lakes (McAlester and Battalion) that would be evaluated before restocking. McAlester is located near an established backcountry camp that receives a high level of use—impacts on meadow vegetation in this area would be negligible to moderate. Battalion is located in a cross-country zone with very low use, and impacts on meadow vegetation would be negligible.

Two of the lakes where fishing would continue have vegetation dominated by forest, and one lake has shoreline vegetation dominated by shrub. One of the lakes dominated by forest and the one lake dominated by shrub are located in cross-country zones or near backcountry camps that experience a low level of use—impacts on forest and shrub vegetation may be negligible. The other lake dominated by forest (100%) is located near a high-use backcountry camp—impacts on vegetation may be negligible to moderate. All three lakes are accessible by stock (horses, mules, llamas).

In this alternative C, 29 lakes (3 in the national recreation areas and 26 in the national park) would remain fishless, and 51 additional lakes (8 in national recreation areas and 43 in the national park) would become fishless. Of the 51 lakes that would become fishless, 43 are classified as having from 2% to 76% meadow in the shoreline. Impacts on riparian vegetation should be monitored at the 2 lakes that would be evaluated prior to restocking. As angler use declines at the 43 lakes, there would be negligible to moderate beneficial effects on meadow vegetation. There are 14 lakes with shoreline meadow that are in cross-country zones or near camps that experience low visitor use—discontinuation of fish stocking or fish removal would have negligible beneficial effects on vegetation at these lakes. For the 19 lakes that are in cross-country zones or near camps that experience medium visitor use or have trail or livestock access, discontinued fish stocking or fish removal would result in negligible to minor beneficial impacts on meadow vegetation. A negligible to moderate beneficial effect would be expected at the 10 lakes with shoreline meadow that are in cross-country zones or near camps that experience high visitor use or have trail or stock access. Negligible impacts from past visitor use at the 29 lakes that are currently fishless would remain or heal in time.

There would be negligible to moderate beneficial effects on vegetation dominated by shrubs at 5 lakes that would become fishless. It was not possible to determine if more resistant high-stature shrubs (such as willows) or sensitive low-lying shrubs (such as heather and huckleberry) are dominant at individual lakes, which is why the range of potential impact is broad. Forest cover is dominant at 1 lake that experiences high visitor use; the impacts of continued fish stocking at this lake may be minor and adverse.

Impacts of Proposed Lake Treatment Methods on Vegetation

Natural Methods. Twenty-one lakes would be treated with natural methods. Impacts on meadow vegetation from anglers would continue until the lakes are sufficiently fished out. These impacts would range from negligible to moderate, and depend on the factors identified earlier; however, the adverse impacts would be short term, and vegetation would return to more natural conditions as fishing declines over time.

Mechanical Methods. Mechanical treatment is proposed for up to 10 lakes. One lake is proposed for spawning habitat exclusion. A 30-foot section of spawning habitat would be covered with rock taken from nearby talus slope and moved by hand to the lake. Adverse impacts on meadow vegetation from covering vegetation with rock and from trampling would be minor to moderate and short term. Setting nets and using electroshocking equipment would result in some trampling, although mitigation by avoiding vegetation and wading near the shore rather than walking through shoreline vegetation would reduce the impact to negligible or minor and short term.

Chemical Method. Under alternative C, chemical treatment is proposed for 25 lakes. There would be a negligible impact on vegetation from chemical removal of trout because chemicals would be applied primarily from a boat and would not affect vegetation. Placing and removing a boat would have some temporary negligible or minor site-specific impacts.

Impacts of Other Mitigation

Impacts of other mitigation would be the same as under alternative B. Additional signs would be posted in riparian areas that were most heavily used to allow for recovery of vegetation. Furthermore, using an adaptive management approach for lakes to be evaluated would provide an opportunity to monitor the level of impact anglers have on vegetation.

Cumulative Impacts

Cumulative impacts would be similar to alternative A (negligible to moderate, adverse, and long term), although potentially reduced because there would be fewer lakes available for stocking/fishing.

Conclusion

Alternative C would provide substantial long-term benefits to meadow and sensitive forest vegetation from the return of 51 additional lakes to fishless conditions compared to alternative A. The majority of these lakes have meadow vegetation, and 29 of the 51 lakes are located in cross-country zones or near camps that receive a medium to high level of use. To the extent this use is attributable to fishing and fishing-related stock use, benefits to vegetation would occur at these lakes. Of the 9 lakes where fishing would continue, 6 are in cross-country zones or near camps that experience light use now, which would most likely continue to have negligible adverse impacts on vegetation. Three lakes are in cross-country zones or near camps that would continue to experience medium or high use, with resulting negligible to moderate adverse impacts on meadow vegetation. One lake may continue to experience minor or even moderate impacts on shoreline forest vegetation. Temporary negligible or minor adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatment would occur, and continued fishing as a means of natural removal would have short-term negligible to moderate adverse impacts. Cumulative impacts would be long term, negligible to moderate, and adverse.

Impairment of vegetation across the study area would not occur under alternative C.

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

Alternative D

91 lakes would be fishless

Alternative D proposes that 29 currently fishless lakes would remain fishless, and 62 lakes would become fishless from discontinuing stocking or removing fish using natural, chemical, or natural treatment methods. The result would be fishless conditions in 91 lakes in the study area. The "Alternatives" chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the "Alternatives" chapter, appendix E, appendix M, and "Map 2" and "Map 2 Table" located in the envelope that accompanied this document.

Impacts of Fish Stocking on Vegetation (Riparian Vegetation)

Adverse impacts on the riparian zone would decline following the return of lakes to fishless conditions, and negligible to moderate beneficial impacts would occur as disturbed meadow areas recover. Of the 62 lakes that would remain fishless or become fishless, 52 are classified as having from 2% to 76% meadow in the shoreline. As noted earlier, meadow vegetation may be particularly sensitive to trampling.

There are 20 lakes with shoreline meadow that are located in cross-country zones or near camps that currently experience low visitor use. Discontinuing stocking and removing fish is expected to have negligible beneficial impacts on vegetation at these lakes. For the 19 lakes that are in cross-country zones or near camps that currently experience medium visitor use or have trail or stock (horses, mules, llamas) access, discontinued fish stocking and fish removal may result in negligible to minor beneficial impacts on meadow vegetation. Negligible to moderate beneficial impacts are expected at the 13 lakes with shoreline meadow that are in cross-country zones or near camps that experience high visitor use or have trail or stock access. Visitor use data is missing for one of the lakes that has shoreline meadow cover.

Vegetation at the 29 lakes that are currently fishless would continue to experience negligible adverse impacts from past visitor use but would be undetectable compared to natural conditions in time.

Impacts of Lake Treatment Methods on Vegetation

Under alternative D, discontinued stocking and fish removal are proposed for 62 lakes.

Natural Methods. Natural treatment is proposed for 26 lakes. Impacts on meadow vegetation from anglers would continue until the lakes are sufficiently fished out. These impacts would range from negligible to moderate and depend on the factors identified earlier; however, impacts would be short term, and vegetation would return to more natural conditions over time as visitor use related to fishing declines.

Mechanical Methods. Mechanical treatment is proposed for 11 lakes. One lake is proposed for spawning habitat exclusion. A 30-foot section of spawning habitat would be covered with rock taken from nearby talus slope and moved by hand to the lake. Adverse impacts on meadow vegetation from covering vegetation with rock and from trampling would be minor to moderate and short term. Setting nets and using electroshocking equipment would result in some trampling, although mitigation by avoiding vegetation and wading near the shore rather than walking through shoreline vegetation would reduce the impact to negligible or minor and short term.

Chemical Method. Chemical treatment is proposed for 25 lakes. Adverse impacts would be negligible and short term because chemicals would be applied from a boat. Dragging a boat across meadow vegetation would have temporary, minor impacts, although these impacts would be easily mitigated by carrying boats.

Impacts of Other Mitigation

Impacts of other mitigation would be the same as under alternative B. Additional signs would be posted in riparian areas that were most heavily used to allow for recovery of vegetation. Furthermore, the adaptive management plans for lakes set for evaluation provide an opportunity to monitor the level of impact anglers have on vegetation.

Cumulative Impacts

Cumulative impacts would be similar to alternative A (negligible to minor, adverse, and long term), although reduced because there would be no lakes available for stocking/fishing.

Conclusion

Under alternative D, 62 additional lakes would be returned to fishless conditions compared to alternative A. Vegetation at these lakes would experience overall beneficial impacts under alternative D. The degree of benefit would range from negligible to moderate and would depend on the level of visitor use, access, sensitivity of the vegetation, and other factors. The majority of these lakes have meadow vegetation. If high visitor use, stock use, and trail use are related to fishing, a decline in fishing opportunity would offer substantial benefits to this more sensitive vegetative community. Temporary negligible or minor adverse impacts on shoreline vegetation from trampling related to chemical or mechanical lake treatment would occur, and continued fishing as a means of natural removal would have short-term negligible to moderate adverse impacts. Cumulative impacts would be negligible to moderate, adverse, and long term.

Impairment of vegetation across the study area would not occur under alternative D.

CULTURAL RESOURCES

GUIDING REGULATIONS AND POLICIES

Federal actions that have the potential to affect cultural resources are subject to a variety of laws.

The *National Historic Preservation Act* (1966, as amended; NHPA) is often the principal legislative authority for managing cultural resources associated with NPS projects. Section 106 of the NHPA requires all federal agencies to consider the effects of their actions on cultural resources determined eligible for inclusion in the National Register of Historic Places (National Register). Such resources are termed "historic properties." Agreement on mitigation of effects to historic properties is reached through consultation with the State Historic Preservation Officer; Tribal Historic Preservation Officer, if applicable; and, as required, the Advisory Council on Historic Preservation (Advisory Council). In addition, the NHPA requires that federal agencies take actions to minimize harm to historic properties that would be adversely affected by a federal undertaking. Section 110 of the NHPA, among other things, charges federal agencies with the responsibility for establishing preservation programs for identification, evaluation, and nomination of historic properties to the NRHP.

Other important laws and regulations designed to protect cultural resources are

> *Native American Graves Protection and Repatriation Act* (NAGPRA), 1990
>
> *American Indian Religious Freedom Act* (AIRFA), 1978
>
> *National Environmental Policy Act* (NEPA), 1969
>
> *Archeological Resources Protection Act* (ARPA), 1979
>
> Executive Order 11593, 1971

In addition, the NPS is charged with protection and management of cultural resources in its custody. This is furthered through the implementation of *NPS-28: Cultural Resources Management Guidelines* (NPS 1997), *NPS Management Policies* (NPS 2001a), and the 1995 Service-wide Programmatic Agreement with the Advisory Council and the National Conference of State Historic Preservation Officers. These documents charge NPS managers with avoiding, or minimizing to the greatest degree practicable, adverse impacts on park resources and values. Although the NPS has the discretion to allow certain impacts in parks, that discretion is limited by the statutory requirement that park resources and values remain unimpaired, unless a specific law directly provides otherwise.

METHODOLOGY AND ASSUMPTIONS

The NPS categorizes cultural resources by the following categories: archeological resources, cultural landscapes, historic structures, museum objects, and ethnographic resources. The actions proposed in the alternatives would have minimal impact on museum objects, and hence, they are not discussed further. A review of reference materials regarding cultural resources in the North Cascades Complex, as well as communications with NPS staff, were completed to identify and evaluate potential impacts on cultural resources located in the study area. The North Cascades Complex contains a number of cultural resources that are eligible or included in the National Register (see the "Cultural Resources" section in the "Affected Environment" chapter).

CEQ regulations require assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts on cultural resources over time can include total loss of sites or parts of sites due to development, soil erosion, or lack of appropriate maintenance; loss of integrity and interpretive value; and the gradual loss of the cultural resource base within a park. Cumulative impacts are considered for both the no-action and action alternatives.

The descriptions of effects on cultural resources that are presented in this section are intended to comply with the requirements of both NEPA and section 106 of the NHPA. In accordance with the Advisory Council's regulations implementing section 106 (36 CFR Part 800, *Protection of Historic Properties*), impacts on cultural resources were identified and evaluated by (1) determining the area of potential effects; (2) identifying cultural resources present in the area of potential effects that are either listed in or eligible to be listed in the National Register; (3) applying the criteria of adverse effect to affected cultural resources either listed in or eligible to be listed in the National Register; and (4) considering ways to avoid, minimize, or mitigate adverse effects.

Under the Advisory Council's regulations, a determination of either *adverse effect* or *no adverse effect* must also be made for affected National Register-eligible cultural resources. An *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the National Register (for example, diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association). Adverse effects also include reasonably foreseeable effects caused by the proposal that would occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5, *Assessment of Adverse Effects*). A determination of *no adverse effect* means there is an effect, but the effect would not diminish, in any way, the characteristics of the cultural resource that qualify it for inclusion in the National Register.

CEQ regulations and *Director's Order 12: Conservation Planning, Environmental Impact Analysis and Decision-making* (NPS 2001b) also call for a discussion of the appropriateness of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential impact; for example, reducing the intensity of an impact from major to moderate or minor. Any resultant reduction in intensity of impact due to mitigation, however, is an estimate of the effectiveness of mitigation under NEPA only. It does not suggest that the level of effect as defined by section 106 is similarly reduced. Cultural resources are nonrenewable resources, and adverse effects generally consume, diminish, or destroy the original historic materials or form, resulting in a permanent loss in the integrity of the resource that can never be recovered. Therefore, although actions determined to have an adverse effect under section 106 may be mitigated, the effect remains adverse.

The "Section 106 Summary" follows the cultural resources impact analyses, and a section 106 statement is included in the conclusion statements for each cultural resource evaluated. The section 106 summary is intended to meet the requirements of section 106 and is an assessment of the effect of the undertaking (implementation of the alternative) on cultural resources, based on the criterion of effect and criteria of adverse effect found in the Advisory Council's regulations.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

For the purpose of this analysis, the "Area of Potential Effect" is defined as the North Cascades Complex.

DEFINITIONS OF INTENSITY LEVELS

Archeological Resources

Negligible: Impact is at the lowest levels of detection – barely measurable with no perceptible consequences, either adverse or beneficial. For purposes of section 106, the determination of effect would be *no adverse effect.*

Minor: **Beneficial effect** – maintenance and preservation of a site(s). For purposes of section 106, the determination of effect would be *no adverse effect.*

Adverse impact – disturbance of a site(s) results in little, if any, loss of integrity. For purposes of section 106, the determination of effect would be *no adverse effect.*

Moderate: **Beneficial effect** – stabilization of a site(s). For purposes of section 106, the determination of effect would be *no adverse effect.*

Adverse impact – disturbance of a site(s) results in loss of integrity. For purposes of section 106, the determination of effect would be *adverse effect.* A memorandum of agreement is executed between the NPS and applicable State or Tribal Historic Preservation Officer and, if necessary, the Advisory Council in accordance with 36 CFR 800.6(b). The mitigation measures identified in the memorandum of agreement would reduce the intensity of impact under NEPA from major to moderate.

Major: **Beneficial effect** – active intervention to preserve a site(s). For purposes of section 106, the determination of effect would be *no adverse effect.*

Adverse impact – disturbance of a site(s) results in loss of integrity. For purposes of section 106, the determination of effect would be *adverse effect.* The NPS and applicable State or Tribal Historic Preservation Officer are unable to negotiate and execute a memorandum of agreement in accordance with 36 CFR 800.6(b).

Historic Structures

Negligible: Impact(s) is at the lowest levels of detection – barely measurable with no perceptible consequences, either adverse or beneficial. For purposes of section 106, the determination of effect would be *no adverse effect.*

Minor: **Beneficial effect** – stabilization/preservation of features in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties.* For purposes of section 106, the determination of effect would be *no adverse effect.*

Adverse impact – impact would alter a feature(s) of a structure but would not diminish the overall integrity of the resource. For purposes of section 106, the determination of effect would be *no adverse effect.*

Moderate: **Beneficial effect** – rehabilitation of a structure in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties.* For purposes of section 106, the determination of effect would be *no adverse effect.*

Adverse impact – impact would alter a feature(s) of the structure, diminishing the overall integrity of the resource. For purposes of section 106, the determination of effect would be *adverse effect.* A memorandum of agreement would be executed between the NPS and applicable State or Tribal Historic Preservation Officer and, if necessary, the Advisory Council in accordance with 36 CFR 800.6(b). The mitigation measures identified in the memorandum of agreement would reduce the intensity of impact under NEPA from major to moderate.

Major: **Beneficial effect** – restoration of a structure in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties.* For purposes of section 106, the determination of effect would be *no adverse effect.*

Adverse impact – impact would alter a feature(s) of the structure, diminishing the overall integrity of the resource. For purposes of section 106, the determination of effect would be *adverse effect*. The NPS and applicable State or Tribal Historic Preservation Officer are unable to negotiate and execute a memorandum of agreement in accordance with 36 CFR 800.6(b).

Cultural Landscapes

Negligible: Impact(s) is at the lowest levels of detection – barely perceptible and not measurable. For purposes of section 106, the determination of effect would be *no adverse effect*.

Minor: **Beneficial effect** – preservation of landscape patterns and features in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*. For purposes of section 106, the determination of effect would be *no adverse effect*.

Adverse impact – impact(s) would alter a pattern(s) or feature(s) of the cultural landscape but would not diminish the overall integrity of the landscape. For purposes of section 106, the determination of effect would be *no adverse effect*.

Moderate: **Beneficial effect** – rehabilitation of a landscape or its patterns and features in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*. For purposes of section 106, the determination of effect would be *no adverse effect*.

Adverse impact – impact(s) would alter a pattern(s) or feature(s) of the cultural landscape, diminishing the overall integrity of the landscape. For purposes of section 106, the determination of effect would be *adverse effect*. A memorandum of agreement is executed between the NPS and applicable State or Tribal Historic Preservation Officer and, if necessary, the Advisory Council in accordance with 36 CFR 800.6(b). The mitigative measures identified in the memorandum of agreement reduce the intensity of impact under NEPA from major to moderate.

Major: **Beneficial effect** – restoration of a landscape or its patterns and features in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*. For purposes of section 106, the determination of effect would be *no adverse effect*.

Adverse impact – impact(s) would alter a pattern(s) or feature(s) of the cultural landscape, diminishing the overall integrity of the resource. For purposes of section 106, the determination of effect would be *adverse effect*. The NPS and applicable State or Tribal Historic Preservation Officer are unable to negotiate and execute a memorandum of agreement in accordance with 36 CFR 800.6(b).

Ethnographic Resources

Some places of traditional cultural use may be eligible for inclusion in the National Register as traditional cultural properties because of their association with cultural practices or beliefs of a living community that (a) are rooted in that community's history and (b) are important in maintaining the continuing cultural identity of the community (*National Register Bulletin, Guidelines for Evaluating and Documenting Traditional Cultural Properties*).

Negligible: Impact(s) would be barely perceptible and would neither alter resource conditions, such as traditional access or site preservation, nor alter the relationship between the resource and the affiliated group's body of practices and beliefs. For purposes of section 106, the determination of effect on traditional cultural properties would be *no adverse effect*.

Minor: **Beneficial effect** – would allow access to and/or accommodate a group's traditional practices or beliefs. For purposes of section 106, the determination of effect on traditional cultural properties would be *no adverse effect*.

Adverse impact – impact(s) would be slight but noticeable but would neither appreciably alter resource conditions, such as traditional access or site preservation, nor alter the relationship between the resource and the affiliated group's body of practices and beliefs. For purposes of section 106, the determination of effect on traditional cultural properties would be *no adverse effect*.

Moderate: **Beneficial effect** – would facilitate traditional access and/or accommodate a group's practices or beliefs. For purposes of section 106, the determination of effect on traditional cultural properties would be *no adverse effect*.

Adverse impact – impact(s) would be apparent and would alter resource conditions. Something would interfere with traditional access, site preservation, or the relationship between the resource and the affiliated group's practices and beliefs, even though the group's practices and beliefs would survive. For purposes of section 106, the determination of effect on traditional cultural properties would be *adverse effect*.

Major: **Beneficial effect** – would encourage traditional access and/or accommodate a group's practices or beliefs. For purposes of section 106, the determination of effect on traditional cultural properties would be *no adverse effect*.

Adverse impact – impact(s) would alter resource conditions. Something would block or greatly affect traditional access, site preservation, or the relationship between the resource and the affiliated group's body of practices and beliefs, to the extent that the survival of a group's practices and/or beliefs would be jeopardized. For purposes of section 106, the determination of effect on traditional cultural properties would be *adverse effect*.

All Cultural Resources

Impairment. The action would contribute substantially to the deterioration of cultural resources in the North Cascades Complex. In addition, any adverse major impacts on the North Cascades Complex's resources and values would

> contribute to deterioration of cultural resources and values to the extent that the purpose of the North Cascades Complex would not be fulfilled as established in its enabling legislation
>
> affect resources key to the natural or cultural integrity or opportunities for enjoyment in the North Cascades Complex
>
> affect the resource whose conservation is identified as a goal in the *General Management Plan* (NPS 1988b) or other planning documents for the North Cascades Complex

IMPACTS COMMON TO ALL ALTERNATIVES

The potential impacts on archeological resources and mitigation measures common to all alternatives are addressed below. For this plan/EIS, archeological resources, historic structures, ethnographic resources, and cultural landscapes are analyzed. A programmatic agreement, as defined in 36 CFR 800.14(b), is designed to address complex federal project situations (for example, when effects on historic properties cannot be fully determined prior to approval of undertaking). A programmatic agreement would be implemented, if necessary.

Under all alternatives, management actions (fish stocking and/or removal) at many of the mountain lakes would result in varying degrees of pedestrian-related ground disturbance in the North Cascades Complex (see tables 4 and 5). Pedestrian access to these lakes by management crews would be via existing roads and trails or cross-country hiking. Crews would be small (1–2 people), and short-term camping would occur. Work around shorelines would be necessary where fragile vegetation and soils would be disturbed. All of these actions have the potential for soil disturbance, which would uncover or damage archeological resources.

Several lakes (less than 10) recommended for fish management actions, and access routes (trails) serving these and other lakes proposed for management actions, have been identified as particularly sensitive regarding the presence and nature of cultural resources. (Because of the sensitive nature of these resources, their location is not publicly available information.)

In general, ground disturbance has the potential to result in adverse impacts of unknown intensity on recorded and unrecorded archeological resources in these areas. Depending on the activity, mitigation measures designed to reduce ground disturbance would be implemented (see appendix I for the current and proposed mitigation measures.

In addition to the mitigation measures identified in appendix I, the following measures may be necessary:

> Surveys by professional cultural resource specialists would proceed any proposed ground disturbance.
>
> If cultural resources are inadvertently unearthed/disturbed during proposed activities, all work in the immediate vicinity would be halted until the resource would be appropriately evaluated and mitigated, if necessary.
>
> Crews would be provided with fundamental training regarding the sensitivity of archeological resources and the need to protect them, as well as instructing them to report any newly discovered cultural resources to the park archeologist.
>
> Evaluation of cultural resources in these identified sensitive areas to determine National Register eligibility would be a significant aid in avoiding adverse impacts on historic properties. Where documented/recorded sites exist, the monitoring of the areas where ground disturbance is proposed would further mitigate any adverse impacts on archeological resources.

For most lakes, these measures would likely mitigate potential adverse impacts from fish management activities to archeological resources to negligible to minor and site specific.

The use of helicopters (and associated landing pads) to transport fish removal equipment to lakes has the potential to create negligible to minor, short-term, adverse visual impacts on cultural landscapes in the North Cascades Complex.

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A (no action) would continue current management of the 91 lakes in the study area. The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.

Alternative A

62 lakes would have fish
29 lakes would remain fishless

Archeological Resources. It is estimated that approximately 1,000 visitors engaged in sport fishing in 2003 at the mountain lakes in the study area (see the "Visitor Use and Experience" section in this chapter). The continuation of existing sport fishing activities involves the use of the study area by anglers who often bring in stock (horses, mules, llamas) and camp overnight for an average of two days per visit (NPS, R. Zipp, pers. comm., 2003), all of which results in ground disturbance. Designated backcountry overnight use areas and camps are shown on "Map 2" and the "Map 2 Table" located in the envelope that accompanied this document. Adverse impacts on archeological resources of unknown intensity are possible as a result. Of particular concern are those resources that have not yet been identified, recorded, and protected by the NPS. Additional visitor educational information and scheduled monitoring of sensitive areas would aid in mitigating potential adverse effects to negligible to minor, over the long term.

Historic Structures. This alternative would probably involve the highest number of anglers, many of whom would spend a night or two in the backcountry where a number of historic structures are known to exist. Consequently, a slightly higher likelihood for adverse impacts (such as vandalism) on historic structures exists than under the other three alternatives. The potential impact intensity on historic structures is unknown but is likely not higher than negligible to minor and site specific given the small number of anglers visiting the areas where structures exist. Systematic and periodic monitoring of resource conditions and additional education of backcountry users (possibly through backcountry permit issuance process) would likely reduce this effect to negligible.

Backcountry homesteads are part of the cultural landscape of the North Cascades Complex.

Cultural Landscapes. Twenty-four cultural landscapes have been identified in the North Cascades Complex; five have been determined eligible for inclusion in the National Register (see the "Affected Environment" chapter). One designated cultural landscape exists at a lake that has been identified as sensitive regarding cultural resources (NPS, J. Kennedy, pers. comm., 2004). This lake and the associated designated cultural landscape currently sustain some of the highest visitor levels in the North Cascades Complex. This particular cultural landscape is believed important because of its mining-related historic structure, features, and artifacts. The continuation of current levels of fishing activities proposed under this alternative would likely result in minor, site-specific adverse impacts on this designated cultural landscape. Periodic and systematic minor monitoring of the resource would further reduce impacts.

This alternative would continue current fishery management practices and angler use. Such activities would result in possible elements of a cultural landscape being inadvertently impacted by physical changes such as the creation of social trails, modification of historic structures, and artifact removal. These activities would result in adverse impacts of unknown intensity, particularly where cultural landscapes have not been inventoried, evaluated, and appropriately protected. For any cultural landscape that is determined to be at risk of impact as a result of this alternative, mitigation measures may be necessary to avoid adverse impacts on historic properties. Mitigation actions (such as systematic recordation, additional cultural resource inventory, National Register eligibility determination, and increased visitor information) would reduce impacts on cultural landscape resources to site specific to localized and minor in intensity. Periodic and systematic monitoring of resource conditions and additional education of backcountry users (possibly through backcountry permit issuance process) would likely reduce this potential impact further.

Ethnographic Resources. Because no ethnographic resources have been documented in the North Cascades Complex, it is unlikely that impacts would occur as a result of the no-action alternative. It is assumed that, should such impacts occur, communications among the NPS, affected Tribes, and the State Historic Preservation Officer would be initiated, and any adverse effects would be mitigated to negligible through a cooperative agreement.

Cumulative Impacts

As is true under all alternatives, a number of cultural resources have undoubtedly sustained adverse impacts from natural and human forces over the lengthy period of human occupation of the area. Because the majority of the North Cascades Complex has not been formally inventoried for cultural resources, any unidentified resources, especially those archeological resources exposed on or located near the surface, would be particularly vulnerable to human and natural impacts. Cumulative natural impacts (erosion, general weathering,) and human impacts (inadvertent ground disturbance, vandalism, artifact collection, digging) that result in resource loss are expected to continue, and possibly increase, creating adverse impacts of unknown intensity on cultural resources. Ultimately, the resource base would be diminished, resulting in an incomplete historical record and likely errors in cultural interpretation as a result. The eventual completion of a North Cascades Complex-wide cultural resource inventory designed to identify/protect historic properties would benefit cultural resources in the region.

Dam and reservoir construction during the 20th century, along with construction of related hydroelectric facilities (including the company towns of Newhalem and Diablo), likely resulted in major cumulative adverse impacts on cultural resources that continue today. Filling of reservoirs (Ross, Diablo, and Gorge lakes) undoubtedly inundated an unknown number of prehistoric and historic cultural resources. Archeological sites are known to currently exist in drawdown zones of Lake Chelan and Ross Lake. It is likely that the degradation of recorded and unrecorded sites along shorelines and drawdown zones as a result of wave action, changing reservoir levels, and recreational activity creates ongoing negligible to major adverse site-specific impacts on cultural resources (depending on the resource). The inventory and appropriate mitigation of these vulnerable resources would be of benefit to these resources.

Ongoing adverse impacts on cultural resources from park visitors other than anglers (hikers/campers/climbers) also exist within the North Cascades Complex. Archeological resources are particularly vulnerable to ground disturbance (see “Impacts Common to All Alternatives” in this section). Cultural landscapes can be adversely affected by a variety of recreational uses. For instance, visual impacts (such as social trails or road and facility construction) can alter character-defining features. Historic resources are exposed to potential impacts of vandalism and alteration, to name two, which can alter their integrity and significance. In general, these cumulative adverse impacts on cultural resources are of unknown intensity and scope because so little of the area has been inventoried and evaluated. Periodic and systematic monitoring of known resource conditions by the NPS likely aids in mitigating adverse impacts to known cultural resources, possibly to the negligible to minor and site-specific level.

Of the numerous lakes and trails used recreationally, several have been identified as sensitive regarding cultural resources. In fact, many of these sensitive lake and trail areas currently experience some of the highest levels of visitor use in the North Cascades Complex, making cultural resources in these areas even more vulnerable to potential cumulative adverse impacts. As is the case with many of the mountain lakes, at least one of these sensitive lake areas requires some cross-country hiking to access it, likely resulting in ground disturbance and other human impacts in areas where cultural resources have not been inventoried. This activity creates the potential for visitors to encounter, if only inadvertently, previously unrecorded and unprotected cultural resources, resulting in possible adverse impacts of unknown intensity. For these sensitive areas, further mitigation measures may be necessary to avoid adverse impacts on historic properties (for example, National Register eligibility evaluations of known sites, additional cultural resource inventory, and increased visitor information) (see the discussion of ground-disturbance potential under “Impacts Common to All Alternatives” that appeared earlier in this section). Implementation of such measures would likely result in negligible to minor, site-specific impacts on cultural resources within these sensitive areas.

Conclusion

Alternative A would not change the number of lakes for fishing or the number of anglers using them over the long term. Potential adverse impacts of unknown intensity on archeological resources would be mitigated to negligible to minor. Mitigation would also help keep impacts on historic structures from exceeding minor levels. Potential impacts on cultural landscapes would be mitigated to no greater than minor. No impacts on ethnographic resources are anticipated. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources. Adverse cumulative impacts would range from negligible to minor over the long term.

Impairment of cultural resources across the study area would not occur under alternative A.

Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)

The emphasis of this alternative is to eliminate or reduce the density of reproducing fish from certain mountain lakes in the study area.

Alternative B

- 29 lakes would have fish
- 49 lakes would be fishless
- 13 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

Archeological Resources. The adverse effects described in alternative A would be similar under alternative B. Impacts on archeological resources of unknown intensity as a result of sport fishing activities would occur. With mitigation, these adverse site-specific impacts would be reduced to negligible to minor over the long term.

Alternative B proposes fish removal by a variety of means. Lake treatment methods include natural (cease stocking, increase fishing limits), mechanical (gill netting/electrofishing, fyke nets, trapping, and spawning habitat exclusion), and chemical (piscicide such as antimycin). NPS implementation of all these techniques would result in potential ground disturbance with impacts on archeological resources as described earlier in the "Impacts Common to All Alternatives" section. Negligible to minor archeological resource impacts, with proposed mitigation, would occur over the long term.

The use of mechanical and chemical means of fish removal would require the use of transport helicopters and landing pads. Many lakes would have adequate natural landing areas that would not require ground disturbance (such as leveling) for preparation (NPS, R. Mierendorf, pers. comm., 2004). In these cases, it is unlikely that cultural resources would be impacted; however, review by a cultural resource professional of the surface area prior to its use as a landing pad would ensure this. In those cases where ground preparation is required for helicopter landing, there would be potential for adverse impacts of unknown intensity to archeological resources. The surface survey and monitoring of the ground disturbance of these areas by a cultural resource professional would mitigate these site-specific impacts to negligible to minor over the long term.

Historic Structures. Fewer anglers, but more fishery management actions would occur under alternative B. The potential impact intensity under alternative B for historic structures is unknown but is likely not higher than negligible to minor and site specific given the small number of anglers visiting the area. Periodic and systematic monitoring of resource conditions and additional education of backcountry users (possibly through backcountry permit issuance process) would likely reduce this potential impact further.

Cultural Landscapes. The nature of angling and related activities would remain similar to that currently observed, with many anglers typically spending a night or two in the backcountry where a number of cultural landscape resources exist. Due to the slightly fewer numbers of anglers, alternative B would result in a modest reduction in the likelihood of adverse impacts on cultural landscapes when compared to alternative A. The intensity of potential impacts on cultural landscapes under alternative B is unknown because so many identified resources remain unevaluated. For any cultural landscape that is determined to be at risk of impact as a result of the implementation of alternative B, mitigation measures may be necessary to avoid adverse impacts on historic properties (refer to the discussion under "Impacts Common to All Alternatives" in this section and "Appendix I: Mountain Lakes Fishery Current and Proposed Mitigation Practices").

Impacts on the designated cultural landscapes that were noted in alternative A would be minor in alternative B.

Ethnographic Resources. Ethnographic resources have not been documented in the North Cascades Complex, so it is unlikely that impacts would occur as a result of alternative B. It is assumed that, should such impacts occur, communications among the NPS, affected Tribes, and the State Historic Preservation Office would be initiated, and any adverse effects would be mitigated to negligible through a cooperative agreement.

The proposed use of chemical methods for fish removal would temporarily affect water quality, possibly an issue for Native Americans who may use some of these water bodies for traditional contemporary purposes (ceremonial bathing, vision quests). Depending on the location, amount, and type of chemicals used, such actions would result in adverse impacts of unknown intensity to such ethnographic resources. Impacts would be mitigated to negligible through an agreement among the NPS, affected Tribes, and the State Historic Preservation Office regarding when and where such removal methods would be used and in a manner that would not adversely affect these resources.

Cumulative Impacts

Cumulative impacts would be similar to those described under alternative A and would range from adverse negligible to minor over the long term.

Conclusions

Possible impacts on archeological resources that would result from preparation of mechanical fish removal equipment and helicopter use (and associated landing pads adjacent to lakes) to transport the equipment would be mitigated to negligible to minor through survey and monitoring prior to use. Possible adverse impacts on historic structures are of unknown magnitude but would not likely exceed negligible to minor. Potential impacts on identified cultural landscapes would be mitigated to no greater than minor. The temporary water-quality degradation from chemicals used to remove fish would potentially result in adverse impacts of unknown intensity to ethnographic resources used by Native Americans for traditional purposes. Such impacts would be mitigated to negligible through an agreement with the NPS, affected Tribes, and the State Historic Preservation Office regarding the timing of management activities and locations of specific areas that should be avoided. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources. Adverse cumulative impacts would range from negligible to minor over the long term.

Impairment of cultural resources across the study area would not occur under alternative B.

Alternative C: Proposed Adaptive Management of 91 Lakes under a New Framework (11 Lakes May Have Fish)

Under alternative C, 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish and 2 lakes would be evaluated for restocking. Eleven other lakes in the national recreation areas would remain fishless or be returned to fishless conditions. The remaining 69 lakes (which are in the national park) would be returned to their natural fishless conditions or would remain fishless.

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter and appendix E.

Archeological Resources. In the long term, and when compared to alternative A, sport fishing activities would be further reduced under alternative C, resulting in negligible impacts on archeological resources in general. Alternative C also proposes that one lake identified as sensitive be returned to its natural fishless state. This lake area and its trail access contain a substantial number of archeological resources. In the long term, this reduction in the number of anglers to this lake and its access route represents a long-term benefit for cultural resources.

Historic Structures. Activities would involve a small number of anglers spending a night or two in the backcountry where historic structures are known to exist. With fewer anglers, the likelihood for adverse impacts (such as vandalism) on historic structures would be further reduced, likely to the negligible level in the long term. In addition, one lake that has been identified as sensitive, particularly for historic resources, would revert to a fishless condition under this alternative. This lake sustains some of the highest visitor numbers of all 91 lakes in the study area. Reducing anglers at the lake and its access trail would notably reduce risk of adverse impacts, a benefit to the historic resources around this lake.

Cultural Landscapes. As is the case under all alternatives, a number of cultural landscapes remain unevaluated in the study area. This alternative would result in fewer numbers of anglers than under alternatives A. Fishing activities would involve a small number of anglers spending a night or two in the backcountry where cultural landscapes have been identified. With fewer anglers, the likelihood of adverse impacts on cultural landscapes would be further reduced, but of unknown intensity. For any cultural landscape that may be determined at risk of adverse impacts as a result of this alternative, mitigation measures (such as systematic recordation, additional cultural resource inventory, National Register eligibility evaluation, and increased visitor information) would aid in

reducing impacts on cultural landscapes to site specific to localized and negligible to minor in intensity.

More specifically, one designated cultural landscape exists at a lake that has been identified as sensitive regarding cultural resources, particularly historic resources (NPS, J. Kennedy, pers. comm., 2004). This lake would revert to a fishless condition under alternative C. The lake area and its associated cultural landscape currently sustain some of the highest visitor numbers of all 91 lakes in the study area. Elimination of anglers in this area would notably reduce risk of adverse impacts, a benefit to cultural landscape resources around this lake.

Ethnographic Resources. Impacts on ethnographic resources under alternative C would be similar to those described in alternative B.

Cumulative Impacts

The removal of fish or maintaining fishless conditions in 80 mountain lakes in the study area would ultimately reduce human activity related to fishing and, over the long term, fishery management, thereby reducing ground disturbance to a greater degree than under alternative A. Over time, fewer visitors (anglers, fish management crews) to a number of the lakes and their access trails would result in a cumulative, localized, long-term benefit for cultural resources by reducing exposure to human activity.

Conclusions

The impact of reduced sport-fishing opportunities would result in negligible impacts on archeological resources in general, with beneficial effects as a result of the return of one lake identified as sensitive to a fishless state. Adverse impacts on historic structures are likely to be negligible; the elimination of fishing at one particularly sensitive lake would result in a benefit to historic structures. Cultural landscapes in the study area may incur no greater than minor adverse impacts; in one case, a benefit to the resources would be realized. Impacts on ethnographic resources would likely be mitigated to negligible. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources. There would be cumulative beneficial effects for cultural resources from reduced human activity at a number of mountain lakes.

Impairment of cultural resources across the study area would not occur under alternative C.

Alternative D

91 lakes would be fishless

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

The goal of this alternative is to remove fish from (or maintain as fishless) all 91 lakes in the study area. The "Alternatives" chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the "Alternatives" chapter and appendix E.

Archeological Resources. All sport fishing would be eliminated under this alternative. While anglers make up only a small number of visitors to the North Cascades Complex, the presence of fish management crews would also be eliminated in the long term, reducing ground-disturbing activities further. Reduction in human activity would be a beneficial effect on archeological resources in the study area, particularly those located in areas identified as sensitive.

Impacts on archeological resources related to fish removal are described under “Impacts Common to All Alternatives” in this section.

Historic Structures. The likelihood for adverse impacts (such as vandalism) on historic structures would be notably reduced, resulting in a benefit in the long term, particularly to those areas that have been identified as sensitive.

Cultural Landscapes. Potential impacts on cultural landscapes from the use of helicopters for fish management activities under alternative D are similar to those described earlier in the “Impacts Common to All Alternatives” section.

More specifically, one cultural landscape exists at a lake that has been identified as sensitive, particularly for historic resources. This lake would revert to fishless under alternative D, as would be the case under alternative C. This lake and the associated cultural landscape currently sustain some of the highest visitor numbers of all 91 lakes in the study area. Elimination of anglers in this area would notably reduce risk of adverse impacts, a minor site-specific to localized benefit to cultural landscape resources around this lake.

Ethnographic Resources. Impacts on ethnographic resources as a result of fish management activities under alternative D would be similar to those described in alternative B.

Cumulative Impacts

Removing fish from 62 mountain lakes in the study area would ultimately reduce human activity. When compared to alternative A, ground disturbance related to fishing and fish management activities would be eliminated over time, likely resulting in cumulative beneficial effects on cultural resources in the North Cascades Complex.

Conclusions

Under alternative D, the long-term effects of elimination of fishing at all of the mountain lakes in the study area would result in reduced human fishing activity, a benefit to archeological resources in the North Cascades Complex. More specifically, those lake and trail areas identified as sensitive regarding cultural resources would incur benefits by way of reduced risk of disturbance. Adverse impacts on cultural landscapes would likely be negligible; minor benefits may be realized at one designated cultural landscape where fishing would be eliminated. For the purpose of compliance with section 106 of the *National Historic Preservation Act*, there would be no adverse effect on cultural resources. Cumulative impacts would be beneficial.

Impairment of cultural resources across the study area would not occur under alternative D.

SECTION 106 SUMMARY

This plan/EIS provides an analysis of impacts on cultural resources of four alternatives (the no-action alternative and three action alternatives). The project involves 91 lakes, 90 of which are located in designated wilderness areas.

Visitors to the North Cascades Complex typically access areas on foot along existing trail networks, though cross-county hiking is required to reach some lake areas. Anglers (and other visitors) occasionally pack in stock (horses, mules, llamas), and their stays are typically one to two nights in designated camp areas. Overnight anglers (approximately 1,000 annually) account for approximately 10.5% of backcountry visitors to study area lakes. Fishery management activities conducted by the NPS and WDFW are also typically accomplished via similar access routes to lake areas, though occasional helicopters or fixed-winged aircraft are used.

The North Cascades Complex consists of approximately 684,000 acres, of which less than 5% has been inventoried for cultural resources. As a result, specific direct impacts on cultural resources are difficult to assess. The use of a Programmatic Agreement as defined under 36 CFR 800.14(b) would be appropriate to ensure that no adverse effects on historic properties result from the implementation of the proposed fishery management plan.

Impacts are currently best assessed in areas that contain known, recorded cultural resources. To the extent possible, impacts have been determined by identifying those areas likely to be impacted (lakes and the access routes [trails] to them) and classifying them as to their sensitivity regarding known cultural resources (presence/nature). While several lakes and trails have been identified as sensitive based on the presence of recorded cultural resources, it is a near certainty that numerous and significant unidentified resources exist in the study area and are vulnerable to impact. The following summarizes effects on all cultural resources whether listed in or determined eligible for the National Register or unevaluated for the National Register.

One of the greatest potential impacts on archeological resources is ground disturbance (from pedestrians or vehicles), a result that would occur from implementation of any of the alternatives. Alternative A (the no-action alternative) would, in the long term, result in the greatest potential for ongoing ground disturbance of all alternatives. While potential impact levels are unknown, the implementation of mitigation measures would likely ensure that adverse impacts would not exceed minor intensity, resulting in *no adverse effect* to archeological resources. In some cases (alternatives C and D), minor benefits to archeological resources would be expected (*no adverse effect*) as a result of reduced human activity.

The continuation of ongoing sport fishing under alternative A would result in negligible to minor adverse impacts on historic structures (*no adverse effect*) which would be mitigated further to negligible. The incremental reduction in sport fishing activities under alternatives B, C, and D would result in varying effects to historic structures, none of which is anticipated to exceed the minor intensity (*no adverse effect*). Alternative D would likely create a negligible to minor benefit to historic structures because of its complete elimination of sport fishing and consequent reduction in human activity, particularly in sensitive areas (*no adverse effect*).

Ongoing sport fishing under alternative A would likely result in adverse impacts on cultural landscapes in the North Cascades Complex, which would be mitigated to no greater than minor (*no adverse effect*). Incremental reduction in sport fishing proposed under alternatives B, C, and D would result in varying effects, none of which would exceed minor intensity (*no adverse effect*). In fact, the reduction of fishing opportunities proposed under alternatives C and D would result in minor benefits (*no adverse effect*) at one designated cultural landscape. Under alternative D, the complete elimination of sport fishing would likely result in negligible to minor, long-term benefits (*no adverse effect*) to cultural landscapes in the North Cascades Complex. The use of helicopters for fish management activities under all alternatives has the potential to create minor visual impacts (*no adverse effect*) to cultural landscapes that would likely be mitigated further.

While the potential to impact ethnographic resources exists under alternative A, no specific resources are known (no recorded resources). The potential to adversely affect ethnographic resources exists to an unknown degree under alternatives B, C, and D in that these alternatives propose chemical fish removal actions; however, any adverse impacts would likely be mitigated to negligible (*no adverse effect*) through negotiated agreements among the NPS, affected Tribes, and the State Historic Preservation Office.

Cumulative major adverse impacts on cultural resources have occurred in the past as a result of the construction of hydroelectric projects (dams, reservoirs, related facilities) in the form of site inundation and destruction (*adverse effect*). These adverse effects were created at a time when little or no formal protection existed for historic properties. In fact, only a small percentage of the North Cascades Complex has been inventoried to date. A North Cascades Complex-wide inventory of cultural resources, including shorelines of reservoirs and lakes associated with the hydroelectric projects where archeological resources are known to exist, would result in major, regional benefits to cultural resources in the North Cascades Complex (*no adverse effect*). Ongoing recreational use of the North Cascades Complex would likely result in no greater than minor adverse impacts on cultural resources (*no adverse effect*). The anticipated reduction of human activity, which would result under alternatives C and D, would likely create negligible to minor cumulative benefits to cultural resources in the long term (*no adverse effect*).

Further reduction of potential adverse impacts on cultural resources would be accomplished by periodic and systematic monitoring of known/recorded cultural resources in the North Cascades Complex. Those cultural resources identified as at risk of adverse impacts would be evaluated for National Register eligibility (if they have not yet been), and where necessary, mitigation measures would be

implemented. These actions would include monitoring, site stabilization, and visitor management actions (signage, interpretive materials). The NPS would actively work with affected Tribes to protect ethnographic resources and privacy for traditional activities.

In cases where they have not been identified as part of this analysis, potential adverse impacts (as defined in 36 CFR 800) on cultural resources listed in or eligible for listing in the National Register would be coordinated between the NPS and the State Historic Preservation Office to determine the level of effect on the property and to determine any necessary mitigative measures.

NPS staff at the North Cascades Complex would continue to educate visitors regarding cultural resource protection, with particular emphasis on surface artifacts, architectural features, and traditional activities. If necessary, additional mitigation measures would be developed in consultation with the State Historic Preservation Officer and affected Tribes. Continuing implementation of the *Cultural Resources Management Guidelines* and adherence to *NPS Management Policies* (NPS 2001a) and the 1995 Service-wide Programmatic Agreement with the Advisory Council on Historic Preservation and National Conference of State Historic Preservation Officers would all aid in reducing the potential to adversely impact historic properties.

Copies of this plan/EIS have been distributed to affected/concerned Native American Tribes, the Washington State Historic Preservation Officer, and the Advisory Council on Historic Preservation for review and comment related to section 106 compliance.

Pursuant to 36 CFR Part 800.5, implementing regulations of the National Historic Preservation Act that address the criteria of effect and adverse effect, the NPS finds that implementing a fishery management plan for the North Cascades Complex, with mitigation measures, would not result in any new adverse impacts, (*no adverse effect*) to archeological sites, historic structures, or ethnographic resources currently identified as eligible for or listed in the National Register. In some cases, benefits to these resources would occur as a result of implementation of the proposed alternatives (*no adverse effect*).

VISITOR USE AND EXPERIENCE

RECREATIONAL USE

GUIDING REGULATIONS AND POLICIES

The *NPS Management Policies* (NPS 2001a) state that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks and that the NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. While recreation is a key component of the *NPS Management Policies*, they also state that "Exotic species will not be allowed to displace native species if displacement can be prevented," and that "All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed - up to and including eradication - if (1) control is prudent and feasible, and (2) the exotic species interferes with . . . native species or natural habitats; or disrupts the genetic integrity of native species."

This dual nature of visitor enjoyment and resource conservation is evident in the NPS *Organic Act of 1916* and subsequent legal interpretations of it. While the NPS is mandated to leave resources "unimpaired for future generations," it also has been directed to conserve resources when conflicts arise between visitor experience and those resources (refer to the "Impairment Analysis" section under "General Methodology" in this chapter). Guiding documents for North Cascades Complex, such as the *Strategic Plan* (NPS 2000a), also address these issues, stating that the purpose of the North Cascades Complex is to

> Preserve for the benefit, use, and inspiration of present and future generations certain majestic mountain scenery, snowfields, glaciers, alpine meadows, and other unique natural features, biological processes, and cultural resources in the North Cascades.
>
> Provide outdoor recreation use and enjoyment for the public, and for the conservation of the scenic, scientific, historic, and other values contributing to public enjoyment within Ross Lake and Lake Chelan National Recreation Areas.

The goals of providing recreational opportunities and protecting the natural systems in the North Cascades Complex are also evident in the objectives of this plan/EIS. With regard to recreation and conservation, the objectives state that this plan/EIS should

> Advance the protection and rehabilitation of native biological integrity by maintaining native species abundance, viability, and sustainability.
>
> Provide a spectrum of recreational opportunities, including sport fishing, while minimizing impacts to the biological integrity of natural mountain lakes.

METHODOLOGY AND ASSUMPTIONS

The purpose of this impact analysis is to identify the level of impact that implementing each of the proposed alternatives would have on recreational opportunities available in the North Cascades Complex.

To determine the impacts on visitor use and experience, two major groups of users important in this analysis were identified: anglers who participate in or value fishing in the mountain lakes in the North Cascades Complex, and non-anglers who participate in other forms of recreation in the North Cascades Complex.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

The study area for this analysis is the North Cascades Complex (see "Map 1" located in the envelope that accompanied this document) and the 91 naturally formed mountain lakes in the North Cascades Complex that currently have, or at one time had, a fish presence as a result of either documented or undocumented fish stocking activities. The 91 lakes addressed in this plan/EIS are scattered throughout the North Cascades Complex: 7 are in Ross Lake National Recreation Area, 15 are in Lake Chelan National Recreation Area, and the remaining 69 are located in the north and south units of North Cascades National Park (for more details, refer to the "Alternatives" chapter).

IMPACT THRESHOLD DEFINITIONS

The impact intensities for visitor use are defined below. Where impacts to visitor experience become moderate or minor, it is assumed that current visitor satisfaction would begin to decline, and the North Cascades Complex would not be achieving some of its long-term visitor goals. The impact thresholds below refer to adverse impacts unless otherwise stated in the analyses as beneficial effects.

Negligible. No impacts on the visitor experience or only temporary effects are expected. There would be little noticeable change in visitor experience (or in the defined indicators of visitor satisfaction) or behavior.

Minor. Desired visitor experience is changed, but without appreciably limiting or enhancing critical characteristics of the experience. Visitor satisfaction remains stable (that is, 20% of the users are not satisfied with their experience). Other areas in the North Cascades Complex would remain available for similar visitor experience and use without derogation of the resources and values of the North Cascades Complex.

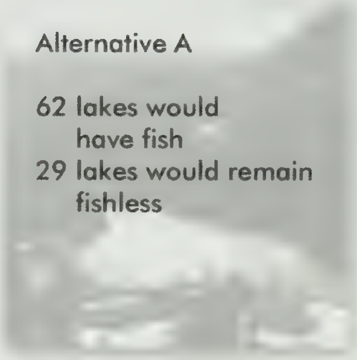
Moderate. Critical characteristics of the desired experience are changed, or the number of participants engaging in an activity is altered. Visitor satisfaction begins to decline (that is, 20% to 50% of the users are not satisfied with their experience). Other areas in the North Cascades Complex would remain available for similar visitor experience and use without derogation of the resources and values of the North Cascades Complex, but some visitors who desire this experience would be required to pursue their choice in other available local or regional areas.

Major. Impacts eliminate or detract from multiple critical characteristics of the desired experience or greatly reduce or increase participation. Visitor satisfaction declines substantially (that is, more than 50% of the users are not satisfied with their experience). Other areas in the North Cascades Complex would remain available for similar visitor experience and use without derogation of the resources and values of the North Cascades Complex. Some visitors who desire this experience would be required to pursue their choice in other available local or regional areas. Other visitors may not be able to duplicate their desired experience elsewhere.

IMPACTS OF THE ALTERNATIVES ON VISITOR RECREATIONAL USE

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A (no action) would continue existing management practices of the 91 lakes in the study area. The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter, appendix E, and "Map 2" and "Map 2 Table" located in the envelope that accompanied this document.



Alternative A

62 lakes would have fish
29 lakes would remain fishless

Visitation increased throughout the North Cascades Complex between 2000 and 2001, but had decreased during the prior two years (1999 and 2000). The impacts from flooding that occurred in October 2003 have largely been repaired, but the Upper Stehekin Valley Road remains extensively damaged and impassable to vehicles; its fate remains uncertain. Long-term closure of the road would reduce backcountry use of the Stehekin Valley, but it is otherwise assumed that visitation levels for the North Cascades Complex would remain steady over the next 10 years.

The majority (80% in 2002) of the visitors to the North Cascades Complex recreate in Ross Lake National Recreational Area along State Route 20 and do not venture far from the highway corridor. These visitors participate in bicycling, day hiking, picnicking, and fishing, as well as touring the hydroelectric project in the summer. Because these visitors do not travel into the backcountry areas of the North Cascades Complex, which includes the study area's 91 lakes, they likely would experience no effects from implementation of alternative A.

Visitors enjoy other activities in the North Cascades Complex such as boating, paddling, hunting (in the recreation areas only), hiking, camping, mountaineering, horseback riding, and fishing in mountain lakes, creeks, rivers, and reservoirs. No boating or paddling occurs in the mountain lakes. Very few people hunt, which is limited to the national recreation areas, and hunting season typically occurs in the fall and winter, when mountain lakes ice over, and

visitation is low; therefore, no impacts are expected on, or from, these users. Impacts on the remaining visitors to the North Cascades Complex are discussed below.

Impacts on Hikers and Backcountry Campers

Family outing
at Cascade Pass.

Hikers. Day hiking is one of the most popular backcountry activities in the North Cascades Complex. Although most lakes in the park cannot be fished in one day, eight lakes do provide day-use fishing. For most day hikers, these lakes include Hozomeen, Willow, Ridley, Lower and Middle Thornton, Monogram, Coon, and Hidden. These lakes are among the top 10 most popular fishing destinations in the North Cascades Complex. The relative accessibility of these lakes would lead to increased fishing at these locations with future increases in visitation; however, day-use anglers represent a small number of overall day-use visitors. Increased fishing of popular day-use lakes would result in a long-term, adverse impact on day-use visitors seeking solitude, although the current fishing pressure on these lakes is so slight that increased fishing pressure would probably have a negligible impact for the foreseeable future.

Some of the day-use lakes were stocked by aircraft in the past, but are currently backpack stocked. Stocking frequency varies by lake (refer to table 6 in the "Alternatives" chapter), although the majority of lakes are stocked only once every four to five years. Stocking typically occurs after lakes thaw (usually early July) and before fall in order for fry to acclimatize to the lakes. The summer months are also when visitation is highest. Day hikers would likely experience negligible impacts to their use and experience from implementation of alternative A because angling would not be expected to noticeably increase, and aircraft stocking of these lakes has been discontinued and replaced with backpack stocking.

Backcountry Campers. The NPS maintains over 200 backcountry overnight campsites. The most commonly used camps occur along the shores of Ross Lake. These sites accommodate between 25% and 40% of all backcountry overnight users (excluding users in cross-country zones). Ross Lake reservoir would not be affected by fishery management actions, so Ross Lake campers would not be affected by management actions under alternative A.

Of the remaining 200 backcountry overnight campsites that are not situated along Ross Lake, numerous camps are located near fishable lakes (see "Map 2" and "Map 2 Table" in the envelope that accompanied this document). Non-anglers who camp at these lakes may possibly share the established camps with anglers, particularly where lakes provide good fishing. In addition, the two McAlester Lake camps, the Hozomeen Lake camp, the Thornton Lake camp, and the Rainbow Lake camp are among the top 10 campsites visited by anglers (see the "Visitor Use and Experience" section in the "Affected Environment" chapter for details).

Camping at Perfect Pass.

Dispersed camping is permitted in cross-country zones, and visitors commonly camp near lakes. Non-anglers camping in cross-country zones near lakes with fish would come into contact with anglers. Given the generally low and dispersed use of cross-country zones, there would be little competition or conflict between anglers and non-anglers for campsites, solitude, or other desired experiences. These visitors would be able to select their own camping locations and would not be required to use or share established campsites.

Visitors to lakes containing stocked fish (at established campsites or within cross-country zones) would experience negative impacts if stocking by aircraft occurred during their visit. Twenty-one lakes in the study area are currently stocked by fixed-wing aircraft. Stocking cycles vary between lakes, and lakes are usually stocked during the summer when visitation is highest. Given the small number of backcountry campers, the low probability of camping at a lake being stocked by aircraft, as well as the short-term and infrequent nature of aircraft stocking activities, non-anglers who camp in the backcountry would experience negligible, adverse, temporary impacts that would occur over the long term.

Impacts on Climbers and Mountaineers

North Cascades is a renowned destination for mountaineering, and bolted sport climbing and bouldering (forms of rock climbing) are becoming increasingly popular in the frontcountry portions of Ross Lake National Recreation Area. However, the frontcountry areas of Ross Lake are not in the study area, so rock climbers would not be affected under alternative A.

Eldorado, Forbidden, and Sahale peaks are the most popular mountaineering destinations. There are also several relatively popular lakes for fishing in these areas, including Trapper, Doubtful, and Hidden. Given the limited amount of backcountry overnight campsites (such as Pelton Basin Camp and Sahale Camp) in this area, mountaineers and anglers may compete for the same backcountry campsites at these popular locations, although there is currently no evidence that competition for backcounty campsites is occurring at this time. Mountaineering occurs throughout the remainder of the North Cascades Complex, though numbers are low and usage is very dispersed. Other than competing for campsites at certain high-use areas, conflict between mountaineers and anglers over campsites would not be expected because these activities generally do not overlap.

Mountaineering in the North Cascades is becoming more popular.

Some mountaineers are believed to also fish while visiting the North Cascades Complex, and these individuals likely view fishing as an enjoyable component of their mountaineering experience. Mountaineers who fish would perceive no impacts to their fishing experience because management actions would remain unchanged under alternative A.

Mountaineers who do not engage in or value fishing would experience impacts similar to those described for hikers and backcountry campers regarding noise from fixed-wing aircraft stocking activities. Given the low probability of camping at or traveling near a lake being stocked by aircraft, as well as the infrequent and short-term nature of stocking activities, mountaineers would experience negligible, adverse, temporary impacts that would occur over the long term.

Impacts on Stock Users and Horseback Riders

Many trails and backcountry camps are available for stock use (limited to horses, mules, and llamas); there are 29 backcountry camps in the entire North Cascades Complex available for stock use. Only 11 of the 91 lakes in the study area are accessible by horseback, and the number of stock users who fish in mountain lakes is not known. Horseback riding is popular on the east side of Lake Chelan in the Stehekin River valley.

Stock users would experience impacts from fixed-wing aircraft stocking at the lakes that are accessible by horseback. Stock users comprise less than 2% of all visitors to the North Cascades Complex, and 7 of the 11 lakes accessible by horseback would be stocked by aircraft under alternative A (refer to table 23 in the "Affected Environment" chapter). Aircraft stocking would occur very infrequently, so the adverse impacts from this activity would be negligible over the long term as stocking activities continue.

Impacts on Anglers

The majority of sport fishing in the North Cascades Complex occurs in the two primary reservoirs: Ross Lake and Lake Chelan, including its tributary, the Stehekin River. Approximately 11.5% of backcountry overnight use involves sport fishing (11.5% pertains to fishing at all water bodies in the North Cascades Complex, not just the 91 lakes). The mountain lakes most frequently fished appear to be those that are most accessible, with a decent potential to catch fish. Based on surveys conducted in the 2003 field season, less than 3% of day users surveyed were fishing (refer to table 25 in the "Affected Environment" chapter). The majority of anglers spend one or more nights in the backcountry because most of the lakes cannot be accessed in one day (see the "Angler Use Summary" section under "Visitor Use and Experience" in the "Affected Environment" chapter).

A young angler.

Under alternative A, anglers would perceive no change to their visitor experience in the North Cascades Complex. Although anglers may be present at lakes when aircraft stocking occurs, this user group is likely to view such activity as compatible with their backcountry experience because aircraft stocking is a common method for maintaining the mountain lake fishery. Impacts on anglers would be beneficial and long term because they would continue to fish at the mountain lakes that are currently available for fishing.

Cumulative Impacts

Alternative A would likely not change angler use inside or outside the boundaries of the North Cascades Complex, so displacement of anglers to lakes outside the NPS boundaries would not be expected. No new resorts or major upgrades to existing visitor facilities are currently planned. No projects are currently proposed or planned that would change road access to any unit of the North Cascades Complex, and no new major trails or trailheads are being considered, although a small section of the Pacific Northwest Trail in the North Cascades Complex is currently under construction. Given the vast number of miles available for hiking throughout the North Cascades Complex (386 miles), this construction would likely have no discernable effects on visitors.

Record flooding in the fall of 2003 damaged or destroyed many trails, roads, and bridges. Most of the flood damage was repaired in the 2004 field season. The upper Stehekin Valley Road remains extensively damaged, and an environmental assessment is being prepared to determine whether or not to repair the damage. For the foreseeable future, visitor use of the upper portion of the Stehekin Valley Road may remain greatly reduced, and this would cause some decline in backcountry visitation to portions of the upper Stehekin Valley. Some visitors might enjoy the increased solitude and wilderness setting, while others might lament the reduced access to backcountry areas in the Stehekin Valley, including fishable lakes. Therefore, the cumulative impacts on visitor use either would be adverse or beneficial to backcountry users in the Stehekin Valley.

When combined with the overall long-term, negligible, adverse impacts on non-anglers, cumulative impacts would be minor to moderate, adverse, and short term, depending on the fate of the Stehekin Valley Road. When combined with the long-term beneficial impacts on anglers, cumulative impacts would be short term, minor to moderate and adverse, depending on the extent of flood damage to trails accessing lakes within the study area.

Conclusion

Impacts on non-anglers under alternative A would primarily be related to noise and disruption from fixed-wing aircraft stocking activities. Such adverse impacts would be negligible and temporary but would continue over the long term as stocking activities continue. Anglers would experience long-term beneficial impacts because they would continue to enjoy fishing activities unchanged from the past. Cumulative impacts would result from the partial loss of the Stehekin Valley Road due to flooding that occurred in the fall of 2003. The fate of the road is currently uncertain. If the road is not repaired, then access to backcountry portions of the Stehekin Valley may be more difficult, and this would reduce the amount of backcountry visitation. Some visitors might enjoy the increased solitude and wilderness setting, while others might lament the reduced access to backcountry areas in the Stehekin Valley, including fishable lakes. Therefore, adverse cumulative impacts on visitor use would be minor to moderate over the long term.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

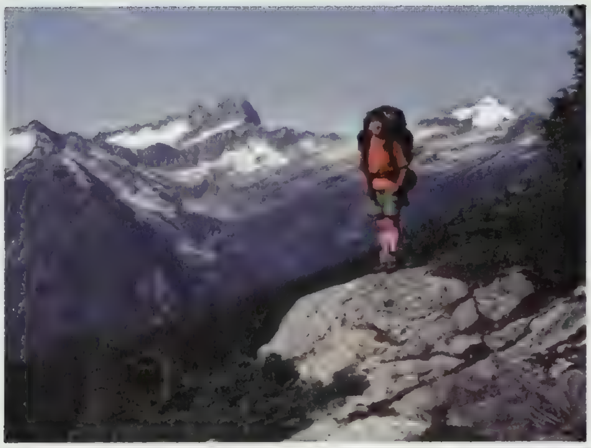
The goal of this alternative is to eliminate or reduce reproducing fish populations from select lakes in the national park and the two national recreation areas. The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter, appendix E, and "Map 2" and "Map 2 Table" located in the envelope that accompanied this document.

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

The majority of the North Cascades Complex's visitors (80% in 2002) recreate in the frontcountry portions of Ross Lake National Recreation Area along State Route 20 and do not venture far from the highway corridor. Because frontcountry visitors do not travel into the backcountry of the North Cascades Complex, they would likely experience no impacts from implementation of alternative B.

Impacts on Hikers and Backcountry Campers



The spectacular view is worth the long hike.

Hikers. Most day-use fishing currently occurs at Hozomeen, Willow, and Ridley, Lower and Middle Thornton, Monogram, Coon, and Hidden lakes. Under alternative B, the reproducing population of brook trout in Hozomeen Lake (one of the most popular fishing destinations in the North Cascades Complex) would be removed, if feasible, and the lake would remain fishless. The reproducing population of cutthroat trout at Monogram Lake would be removed and then restocked after a resting period. Management actions would not change for the other readily accessible day-use lakes, and they would remain available for fishing. The loss of fishing opportunity in Hozomeen lake, and the temporary loss of fishing opportunity at Monogram Lake, might have a beneficial impact on day hikers seeking greater solitude because fewer anglers may be present. The magnitude of this beneficial impact would be very slight because anglers represent a small number of overall day-use visitors to these lakes. For example, of the 244 estimated day users who visited Hozomeen, Willow, and Ridley lakes in 2003, only 7 were estimated to be anglers (refer to table 25).

Under this alternative, strong preference would be given to backpack stocking (stocking frequency varies by lake and occurs during summer months) as opposed to fixed-wing aircraft. Of the lakes listed above, Hidden, Thornton (Lower and Upper), and Monogram might be stocked by aircraft. Aircraft stocking would only be used if it was determined that fish would not survive a long-distance backpack trip. Noise from the presence of aircraft continuing stocking activities would be reduced compared to alternative A since fewer lakes would be stocked. Aircraft stocking occurs very infrequently, so negligible, beneficial impacts on day hikers would continue over the long term.

Under alternative B, up to 49 lakes either would be treated to remove fish or maintained as fishless. Fish removal activities would likely have a short-term, adverse impact on day hikers who may perceive the presence of helicopters, field crews, and the application of chemical (piscicide) or gillnetting/electrofishing treatments as incompatible with their visitor experience. The duration of fish removal treatments would vary according to methods. For example, gillnetting would likely occur over a three-year period. Chemical treatment with the piscicide antimycin would take place over several days in one summer season. Gillnetting/electrofishing would occur during the summer and fall months, which coincide with peak visitor use. Chemical (piscicide) treatment would vary according to fish species and would occur prior to spawning. The timing would be early season for cutthroat trout and later in the season (August or early September) for brook trout (see the "Alternatives" chapter for details). Spawning habitat exclusion, recommended at this point for just one lake (Wilcox/Lillie, Upper) would probably have a negligible impact on day-use visitors because the lake is remote and seldom visited. Natural treatment methods (that is, cessation of stocking) would have a negligible impact on the day-use visitor experience. Only a handful of lakes would be treated in any given season, and most of the lakes would not be accessible by day users. In light of these reasons, the impacts of alternative B on day-use hikers would be negligible.

Mitigation to reduce impacts on day-use visitors from management actions would include visitor education and public outreach to inform the public when and where these actions would take place (see appendix I).

Backcountry Campers. The North Cascades Complex maintains over 200 backcountry campsites. The most commonly used backcountry camps occur along the shores of Ross Lake. These sites accommodate between 25% and 40% of all backcountry users (excluding users in cross-country zones). Because Ross Lake reservoir is not part of this plan/EIS, Ross Lake campers would likely experience no effect from implementation of this alternative.

Reduced angling opportunities at certain lakes under alternative B would reduce the number of backcountry campers at lakes that currently contain fish (refer to “Map 1 Table” and “Map 2 Table”).

Dispersed camping is permitted in cross-country zones, and camping next to lakes in cross-country zones is common. Non-anglers camped in cross-country zones near lakes with fish would come into contact with anglers, although the number of lakes available for fishing would be reduced compared to alternative A. Given the generally low backcountry use at developed camps, and low, dispersed use of cross-country zones, there would be little competition or conflict between anglers and non-anglers for campsites, solitude, or other desired experiences.

Visitors to lakes containing stocked fish (either at formally established campsites or in cross-country zones) would experience negative impacts if stocking activities, particularly stocking by fixed-wing aircraft, occurred during their visit. However, fewer lakes would be available for fishing under this alternative (29) than alternative under A (62), and preference would be given to backpack stocking. Although backpack stocking would also interfere with backcountry campers’ visitor experience, this type of lake stocking would likely be viewed as more compatible and less intrusive. Compared to alternative A, backcountry campers who are also non-anglers would experience beneficial long-term impacts since there would be fewer lakes affected by stocking activities.

Backcountry campers would also be exposed to fish removal activities, as described above for hikers. Backcountry visitors may view such activity as more intrusive, since they may be more interested in achieving a wilderness experience than day users, and have invested considerably more effort to reach the backcountry. Several factors, however, would reduce the potential impact of fish removal on the visitor experience. A small number of lakes would be treated each season, and the lakes proposed for treatment are located in cross-country zones that do not receive high backcountry visitation. The lakes include Lower and

Middle Blum, Triplet Lower and Upper, Diobsud No. 1 and No. 2 (including 3 other lakes in the area), and Wilcox/Lillie (including 4 other lakes in the area). The cross-country zones and camps near the 91 lakes in the study area are shown on "Map 2" and "Map 2 Table." In addition, rangers issuing backcountry overnight use permits would inform campers when fish removal treatments are occurring and would recommend alternate destinations. Therefore, impacts from fish removal efforts would be minor to moderate under alternative B.

Hiking is a popular activity in the North Cascades Complex.

Impacts on Climbers and Mountaineers

As described under alternative A, rock climbers would likely experience no effect under alternative B because they primarily use frontcountry areas around Ross Lake. As described under alternative A, some popular mountaineering peaks are located near lakes that are also popular with anglers, particularly Doubtful Lake, which experiences the highest amount of backcountry fishing visitation in the North Cascades Complex each season and would be stocked under alternative B. Therefore, mountaineers and anglers would share access and may compete for the same backcountry campsites at these locations. Some mountaineers, though, also fish while visiting the North Cascades Complex, and these individuals likely view fishing as compatible with mountaineering. Given the relatively small number of mountaineers that visit the North Cascades Complex, any adverse impacts on mountaineers related to fishing in the backcountry are likely to be negligible. Mountaineers who fish would perceive negligible impacts on their fishing experience.

Mountaineers would experience impacts similar to those described for hikers and backcountry campers regarding stocking activities. The preference given to backpack stocking under this alternative would result in beneficial effects that would occur over the long term. Regarding lake treatment activities, such activities would occur over the course of a few seasons, and not all lakes would be treated at once; therefore, impacts from fish removal treatments would be short term, adverse, and minor.

The overall impacts on mountaineers who do not engage in sport fishing would be beneficial over the long term. Short-term, negligible to minor adverse impacts would occur from lake treatment actions under alternative B over the long term. Mitigation to reduce impacts on visitors from management actions included public outreach to inform the public when and where these actions would take place (see appendix I).

Impacts on Stock Users and Horseback Riders

The high-use areas in the study area are illustrated on "Map 2" and "Map 2 Table" (located in the envelope that accompanied this document). There are 29 backcountry camps in the North Cascades Complex available for stock (horses, mules, llamas) users and horseback riders. Of the 91 lakes, 11 are accessible by horseback. Some of the more popular fishing lakes are in the Lake

Chelan area; these lakes are also accessible by horseback. Management actions for alternative B would include returning some of these lakes to a fishless condition, while others are treated and restocked (refer to "Map 1 Table" and "Map 2 Table"). Impacts of returning some lakes to a fishless condition would be moderate, adverse, and long term for stock users that fish in the lakes in Lake Chelan National Recreation Area. For those stock users and horseback riders who do not engage in sport fishing, impacts from treatment of lakes (mechanical and chemical fish removal) would be minor and adverse over the short term but beneficial over the long term as management actions are completed.

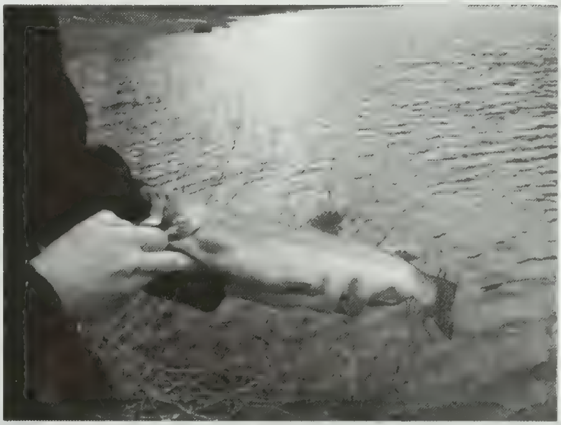
Impacts on Anglers

The majority of sport fishing in North Cascades Complex occurs at Ross Lake reservoir and Lake Chelan, including its tributary, the Stehekin River. Approximately 10.5% of backcountry overnight users fish (in the 91 study area lakes that currently contain fish), and only a few lakes in the North Cascades Complex are visited by day-use anglers; the majority of backcountry mountain lake fishing requires overnight use.

Of the 91 lakes in the study area, approximately 29 would be available for fishing over the long term, compared with 62 under alternative A (refer to tables 5 and 10 in the "Alternatives" chapter). Fish removal would take time and may not be feasible for all lakes targeted for removal; these lakes would continue to be fishable until fish were removed (refer to table 7). Although all lakes that would have fish removed and undergo a resting or evaluation period before being restocked (pertains to 13 lakes) may still be available for fishing, several years (possibly from five to eight) would pass before the lakes would be successfully fished.

Following fish removal or evaluation, some lakes may be restocked, others may not. Anglers would have to wait for stocked fry to mature to a catchable size, and thus, some of these lakes may not be immediately available for fishing, which would increase the amount of adverse impact anglers would experience. Since the majority of lakes affected are in the backcountry, overnight or backpacking anglers would be most affected by alternative B, compared to day-use anglers.

Of the most popular day-use fishing destinations, only Hozomeen Lake would become fishless under alternative B. Willow and Ridley lakes, which are located in the same area, would continue to be stocked. Lower and Middle Thornton, Hidden, and Coon lakes, which are also popular day-use fishing destinations, would continue to be stocked as well. Monogram Lake would be stocked after reproducing fish are removed.



Cutthroat trout from Willow Lake (top). Brook trout from Hozomeen Lake (bottom).

Lake treatment methods to remove fish would adversely affect some anglers' experience. As described for other park visitors, the presence of helicopters and equipment, such as gillnets, would be disruptive over the short and long term because fish removal would be a long, slow process. Therefore, the impact on anglers from lake treatment methods would be minor to moderate and adverse over the short and long term.

Fewer mountain lakes would be available for fishing under alternative B compared to alternative A (see table 5 in the "Alternatives" chapter). The impact to anglers from lost fishing opportunity compared to alternative A would be moderate and adverse over the long term, particularly for some anglers who enjoy fishing a particular lake or group of lakes. If a favorite lake were no longer available for stocking, some anglers may not choose to sport fish in other available lakes or may not return to the North Cascades Complex at all. This loss of fishing opportunity for these anglers would be a major, adverse, long-term impact.

Cumulative Impacts

Under alternative B, 20 lakes would be returned to a fishless condition, and 13 other lakes would be evaluated to determine if they should be restocked. This net loss of fishing opportunity would displace some day-use and backcountry anglers to lakes outside the North Cascades Complex, including those in Ross Lake and Lake Chelan National Recreation Areas and surrounding areas outside NPS boundaries. NPS angler survey data suggest that approximately 1,000 anglers fish in mountain lakes annually (see the section titled "Visitor Use and Experience" in the "Affected Environment" chapter). For this displacement analysis, it is assumed that 50% of anglers (approximately 500 anglers per year) would be displaced from fishing in the national park and may choose to fish in other lakes outside the North Cascades Complex.

There are approximately 400 lakes available for sport fishing within a 100-mile radius of the North Cascades Complex, and many of these lakes are located on adjacent U.S. Forest Service lands (WDFW, M. Downen, pers. comm., 2004). The additional use of 500 anglers spread across 400 lakes would have a negligible cumulative impact on those lakes, though it is unlikely that anglers would be evenly displaced across such a broad area. A more reasonable scenario would involve angler displacement to relatively similar terrain found on adjacent Forest Service wilderness areas such as the Glacier Peak Wilderness. According to WDFW fishery biologists (WDFW, B. Pfeifer, pers. comm., 2004), some of the more readily accessible lakes on adjacent Forest Service lands are already overused by anglers. Additional use of these lakes by anglers displaced from the North Cascades Complex would have a cumulative, adverse impact on visitor use and experience in those areas. The magnitude of impact would depend on individual values and expectations and would range from negligible to minor.

Damage caused by floods is a chronic problem for NPS management. This photo shows a December 2004 debris flow on Rhode Creek that blocked the entrance to Colonial Creek campground in Ross Lake National Recreation Area.

After several years of drought, the North Cascades Complex experienced exceptional flooding in the fall of 2003. Many trails and several roads were damaged or destroyed. Most of the damage was repaired during the 2004 field season, with the upper Stehekin Valley Road being a notable exception. An environmental assessment is currently underway to evaluate alternatives for the extensively damaged road. Although the fate of the road remains uncertain, for the foreseeable future, visitor use of the Stehekin Valley would be lower because road access into the valley has been greatly reduced. Some visitors might enjoy the increased solitude and wilderness setting, while others might lament the reduced access to backcountry areas in the Stehekin Valley, including fishable lakes. The cumulative impacts on visitor use from flooding either would be minor adverse or beneficial to backcountry users in the Stehekin Valley.

Conclusion

Adverse impacts on non-anglers under alternative B would primarily be related to lake treatment methods. These adverse impacts would be negligible to minor over the long term. Removal of fish from some lakes would reduce visitor use and have some long-term beneficial impacts on non-anglers seeking greater solitude in the backcountry. Impacts on most anglers overall would be minor to moderate, adverse, and long term from management actions under alternative B compared to alternative A. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere. Cumulative impacts related to angler displacement to overused areas outside the North Cascades Complex would overall be minor to moderate, adverse, and long term. The cumulative impact of reduced access in the Stehekin Valley due to flood damage would be minor adverse or beneficial to backcountry users.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

The emphasis of this alternative is to eliminate fish from (or maintain as fishless) 80 of the 91 lakes in the study area; 69 of the 80 lakes are in the national park portion of the North Cascades Complex. Sport fishing would still be allowed in 9 lakes in Ross Lake and Lake Chelan National Recreation Areas. Reproducing fish populations in 2 lakes in the recreation areas would be evaluated, and after evaluation, the lakes may be stocked with nonreproducing trout. Sport-fishing opportunities in the national park would gradually decline over time as stocked fish populations died off, and reproducing populations of fish were gradually removed, although removal of reproducing populations from the national park might not be feasible for some lakes (refer to table 7). If removal proved infeasible, these lakes would continue to provide sport-fishing opportunities for the foreseeable future. For lakes with stocked fish, after about 5 years, most fish would be gone and the quality of fishing would drop sharply (WDFW, M. Downen, pers. comm., 2004). Sport fishing in the national recreation areas would still be allowed, although reproducing populations of fish would be removed. In some cases the lakes would be restocked with trout that are incapable of reproducing.

Alternative C

- 9 lakes would have fish
- 80 lakes would be fishless
- 2 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter, appendix E, and "Map 2" and "Map 2 Table" located in the envelope that accompanied this document.

Impacts on Hikers and Backcountry Campers

Day Hikers. Day-use angling currently occurs at Hozomeen, Willow, Ridley, Lower and Middle Thornton, Monogram, Coon, and Hidden lakes. Under this alternative, Hidden, Hozomeen, Monogram, and Lower and Middle Thornton lakes would become fishless. Willow, Ridley, and Coon (which are all popular fishing destinations) would continue to be stocked. Anglers represent a small number of overall day-use visitors, so a decrease in the amount of fishable mountain lakes would have a slight beneficial effect to day hikers because fewer people may be hiking the trails.

Willow, Ridley, and Coon lakes would continue to be stocked. Up to 56 lakes would be treated to remove fish: 25 chemically, 10 mechanically, and 21 by natural treatment (fish would be eliminated by cessation of stocking, experiencing a natural die-off). Removal of fish would be a lengthy process, and only a handful of lakes would be treated in any given year. Day hikers would be negatively affected by fish removal activities (including transporting fish removal equipment with helicopters, use of motorized equipment, presence of work crews around lakes, and gillnetting) because they may perceive these activities as incompatible with their visitor experience. The impacts of fish removal on day hikers would be longer in duration than under alternative B because more lakes would be slated for fish removal. As in alternative B, only a handful of lakes would be treated in a season, so only a small portion of lakes in the North Cascades Complex would be affected each year. In addition, most of the lakes would not be accessible by day users, so fishery management actions would only affect a small portion of the North Cascades Complex. In contrast to alternative B, several more day-use lakes would undergo fish removal, leaving a greater number of day users impacted over the long term. In light of all these reasons, the impacts of fish removal on day-use hikers would be negligible to minor.

To mitigate the impacts of fish removal actions of the visitor experience, the NPS would provide information about fish removal schedules and locations, and educational programs would be provided as described under alternative B.

Backcountry Campers. Camping next to lakes (with and without fish) is common throughout the backcountry. The campsites located next to lakes are shown on "Map 2 Table," and the management actions for alternative C are shown on "Map 1 Table."

The majority of non-anglers visiting lakes that would contain fish under alternative C may share the camps with anglers but only in the national recreation areas. The reduction of available backcountry lakes for fishing would either concentrate anglers in sites at those remaining lakes that provide fishing, thus increasing visitation and competition for limited camping sites (the impacts of angler displacement are discussed in the "Cumulative Impacts" section below). With such limited angling pressure in the backcountry, the impact of increased competition for campsites near national recreation area lakes with fish would probably be negligible. Dispersed camping is permitted in cross-country zones, and camping next to lakes (both with and without fish) is common. Visitors in these areas would be able to select their own camping locations and would not be required to use or share established campsites.

Fewer lakes would be available for fishing under this alternative. Visitors to lakes containing stocked fish (either at campsites or in cross-country zones) would experience negative impacts if stocking activities, particularly stocking by fixed-wing aircraft, occurred during their visit; preference would be given to backpack stocking. Although backpack stocking would also interfere with backcountry campers' visitor experience, this type of lake stocking would likely be viewed as more compatible and less intrusive. In addition, only lakes in the national recreation areas would be stocked; therefore, compared to alternative A, backcountry campers would experience temporary, negligible, beneficial impacts over the long term.

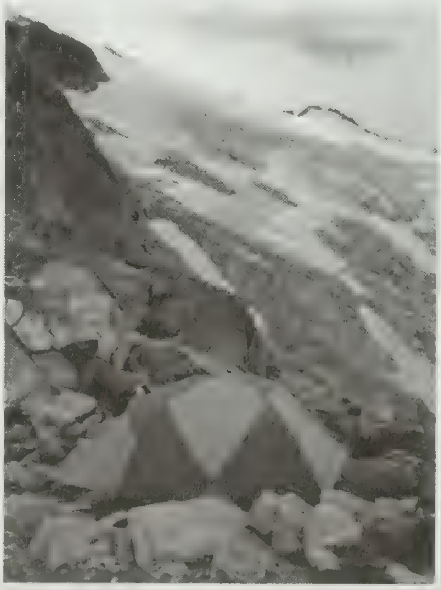
Backcountry campers would also be exposed to fish removal activities. Backcountry visitors may view such activities as more intrusive, since they may be more interested in achieving a wilderness experience than day users and may have invested considerably more effort to reach the high mountain camps. Rangers issuing backcountry overnight use permits would inform campers when fish removal treatments were occurring and would recommend alternate destinations.

Overall impacts on hikers and backpackers under alternative C would be beneficial related to stocking activities but minor to moderate and adverse related to lake treatments to remove fish.

Impacts on Climbers and Mountaineers

As described under alternative A, rock climbers would likely experience no effect under alternative C because they primarily use frontcountry areas around Ross Lake.

Mountaineers who travel the backcountry may encounter anglers on trails or at camps. As described under alternative A, Eldorado, Forbidden, and Sahale peaks are popular mountaineering destinations. The lakes near these popular destinations would be returned to fishless conditions, thereby reducing the potential competition between mountaineers and anglers for limited camping sites.



A base camp at Pioneer Ridge.

The number of lakes stocked under alternative C compared to A would be reduced; therefore, the impact of stocking activities to visitors engaged in mountaineering would be negligible to minor over the long term. Lake treatment methods to remove fish would result in a minor to moderate adverse impact to visitors engaged in mountaineering since most of the lakes are located outside the areas where visitors climb. There would be a negligible beneficial impact on climbers in that the number of people using the study area may be reduced if numbers of anglers are reduced.

Overall impacts on mountaineers under alternative C would be beneficial related to stocking activities but adverse related to fish removal treatments. These adverse impacts, however, would be short term and largely avoidable if climbers chose to access other areas with lakes not undergoing treatment.

Impacts on Stock Users and Horseback Riders

"Map 2" (located in the envelope that accompanied this document) illustrates where the high-use areas are within the study area. There are 29 backcountry camps in the North Cascades Complex available for stock (horses, mules, llamas) users and horseback riders. Of the 91 lakes, 11 are accessible by horseback. Some of the more popular fishing lakes are in the Lake Chelan National Recreation Area and also accessible by horseback. Management actions for alternative C include returning some of these lakes to a fishless condition, while others are treated and restocked (refer to tables 5 and 12 in the "Alternatives" chapter).

Impacts from fish stocking activities and application of lake treatments would be similar to those described under alternative B, particularly because most horseback riding occurs in the Lake Chelan National Recreation Area, which would continue to experience stocking activities. As under alternative B, only Coon Lake would continue to be stocked by aircraft.

For those stock users and horseback riders who also engage in sport fishing in the Lake Chelan Recreational Area, impacts of returning some lakes to a fishless condition would be moderate, adverse, and long term. For those stock users and horseback riders who do not engage in sport fishing, impacts from treatment of lakes (mechanical and chemical fish removal) would be minor and adverse over the short term, but beneficial over the long term as management actions are completed.

Impacts on Anglers

The majority of sport fishing at the North Cascades Complex occurs at Ross Lake and Lake Chelan, including its tributary, the Stehekin River. Approximately 10.5% of backcountry overnight use near the 91 study area lakes involves sport fishing, and only a few lakes in the North Cascades Complex are visited by day-use anglers (the majority of high mountain lake fishing requires overnight use).

Of the 91 lakes in the study area, approximately 9 would be available for fishing over the long term, compared with 62 under alternative A. Although the lakes that would have fish removed and undergo a resting or evaluation period before being restocked may still be available for fishing, several years (possibly five to eight) would pass before the lakes would be successfully fished.

After fish removal or evaluation occurs, some lakes may be restocked, others may not. Anglers would have to wait for fry added to restocked lakes to mature to a catchable level. Therefore, some of these lakes may not be immediately available for fishing, increasing the amount of adverse impact anglers would experience in the form of lost fishing opportunity. Since the majority of lakes affected are in the backcountry, overnight or backpacking anglers would be most affected by alternative C compared to day-use anglers.

Lake treatment methods to remove fish would adversely affect some anglers' experience. As described for other park visitors, the presence of equipment, such as helicopters, motorboats, and gillnetting/electrofishing, would be disruptive over the short and long term. Fish removal would be a long, slow process, and many lakes would remain fishable for some time; therefore, the impact to anglers from lake treatment methods would be minor to moderate and adverse over the short and long term.

Fewer mountain lakes would be available for fishing under alternative C compared to alternatives A and B (refer to tables 5, 10, and 12 and figure 4 in the "Alternatives" chapter). Day-use anglers would experience long-term adverse impacts. Under this alternative, Hidden, Hozomeen, Monogram, and Lower and Middle Thornton lakes, which are popular with day-use anglers, would become fishless, but Willow, Ridley, and Coon lakes would continue to be stocked.

The impact to anglers from lost fishing opportunity compared to alternative A would be moderate and adverse over the long term. Some anglers enjoy fishing a particular lake or group of lakes and believe that fishing in the North Cascades National Park provides a unique fishing experience that cannot be duplicated elsewhere. For these anglers, loss of fishing opportunity in the national park would be a major, adverse, long-term impact.

Anglers might benefit from decreased noise and disturbance associated with aircraft stocking activities that would occur under this alternative, although it is likely that they view such activity as compatible with their visitor experience. As described for other users, anglers would also experience adverse impacts as a result of intensive treatments to remove fish.

Backcountry fishing opportunities would still be available in Ross Lake and Lake Chelan National Recreation Areas, but these opportunities would not suffice for some anglers who believe that fishing in the national park provides an experience that cannot be duplicated elsewhere. Anglers would also experience short-term, negligible, adverse impacts from fish removal treatments. Overall impacts would be moderate to major on some backcountry anglers but minor to negligible for others.

Cumulative Impacts

One cumulative impact issue for recreational use under alternative C would involve displacement of anglers to other areas due to lost fishing opportunity in the national park. Under alternative C, approximately 80 of the 91 lakes in the study area would be fishless over time (69 of those lakes are in the national park portion of the North Cascades Complex). In 9 lakes in Ross Lake and Lake Chelan National Recreation Areas, sport fishing would still be allowed. Reproducing populations of fish in 2 lakes in the recreation areas would be evaluated, and after evaluation, the lakes may be stocked with nonreproducing trout. This net loss of fishing opportunity would displace some day-use and backcountry anglers to lakes outside the North Cascades Complex, including the lakes in the two national recreation areas and surrounding area. NPS angler survey data suggest that approximately 1,000 anglers fish in mountain lakes annually (see the section titled "Visitor Use and Experience" in the "Affected Environment" chapter). For this displacement analysis, it is assumed that 50% of

anglers (approximately 500 anglers per year) would be displaced from fishing in the national park and may choose to fish in other lakes outside the North Cascades Complex.

There are approximately 400 lakes available for sport fishing within a 100-mile radius of North Cascades Complex boundaries, and many of these lakes are located on adjacent U.S. Forest Service lands. The additional use of 500 anglers spread across 400 lakes would have a negligible cumulative impact on those lakes, although it is unlikely that anglers would be evenly displaced across such a broad area. A more reasonable scenario would involve angler displacement to relatively similar terrain found on more adjacent Forest Service wilderness areas such as the Glacier Peak Wilderness. According to WDFW fishery biologists, some of the more readily accessible lakes on adjacent Forest Service lands are already overused by anglers (WDFW, B. Pfeifer, pers. comm., 2004). Additional use of these lakes by anglers displaced from the national park would have a cumulative, adverse impact on visitor use and experience. The magnitude of impact would depend on individual values and expectations and would range from negligible to minor.

Record flooding in October 2003 damaged or destroyed many trails and several roads. Most of the damage was repaired during the 2004 field season, with the upper Stehekin Valley Road being a notable exception. An environmental assessment is currently underway to evaluate alternatives for the extensively damaged road. Although the fate of the road remains uncertain, for the foreseeable future, visitor use of the Stehekin Valley may be lower because road access into the valley has been greatly reduced. Some visitors might enjoy the increased solitude and wilderness setting, while others might lament the reduced access to backcountry areas in the Stehekin Valley, including fishable lakes. Therefore, the cumulative impacts on visitor use from flooding would be minor adverse or beneficial to backcountry users in the Stehekin Valley.

Conclusion

Adverse impacts on non-anglers under alternative C would be primarily related to lake treatment methods. These impacts would be negligible to minor and adverse over the long term. Removal of fish from some lakes would reduce visitor use and have some long-term beneficial impacts on non-anglers seeking greater solitude in the backcountry. Impacts on most anglers overall would be minor to moderate, adverse, and long term from management actions under alternative C compared to alternative A. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere. Cumulative impacts related to angler displacement to overused areas outside the North Cascades Complex would overall be minor to moderate, adverse, and long term. The cumulative impact of reduced access in the Stehekin Valley due to flood damage would be minor adverse or beneficial to backcountry users.

ALTERNATIVE D: 91 LAKES WOULD BE FISHLESS

The emphasis of this alternative would be to remove fish from 62 of the 91 lakes in the study area, with the other 29 lakes remaining fishless. Sport-fishing opportunities in most of these lakes would generally be eliminated within a period of 5 years. Self-sustaining (reproducing) populations of fish would be gradually removed over time. The rate of removal would depend on unpredictable changes in resource (funding and personnel) availability and differences among fish removal methods. Complete removal of self-sustaining populations of fish in some of the larger, deeper lakes might not be feasible (a feasibility analysis is provided in the "Alternatives" chapter). These lakes would continue to provide sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved. For lakes with stocked fish, after about 5 years, most fish would be gone and the quality of fishing would sharply drop (WDFW, M. Downen, pers. comm., 2004).

Alternative D

91 lakes would
be fishless

The "Alternatives" chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the "Alternatives" chapter, appendix E, and "Map 2" and "Map 2 Table" located in the envelope that accompanied this document.

Impacts on Hikers and Backcountry Campers

Day Hikers. Elimination of mountain lake fishing opportunities in the North Cascades Complex would have a slight beneficial effect to day hikers seeking solitude because fewer anglers would be hiking the trails. This benefit would be offset through time, however, given projected increases in visitation from population growth in the surrounding area. In addition, anglers represent a small number of overall day-use visitors in the backcountry. Fish stocking activities would cease entirely, resulting in a long-term, beneficial impact on day hikers.

Under alternative D, 62 of the 91 study area lakes that currently contain fish would be treated to remove fish. Fish removal activities would have a short-term, adverse impact on day hikers, as described under alternatives B and C. Information about fish removal schedules and locations and educational programs would be provided as described under alternative B. Removal of fish from lakes using mechanical and chemical methods would take many years, so day hikers would have ample opportunities to visit areas unaffected by fish removal actions; therefore, the short-term adverse impacts of fish removal activities would likely be minor to possibly moderate.

Backcountry Campers. Backcountry visitors would be adversely impacted by fish removal activities such as gillnetting/electrofishing and chemical (piscicide) application. Backcountry visitors may view such activities as more intrusive since they might be more interested in achieving a wilderness experience than day users and would have invested considerably more effort to reach the high mountain camps. To mitigate this impact (see appendix I), rangers issuing backcountry overnight use permits would inform campers when and where fish removal treatments were occurring and would recommend alternate destinations.

Backcountry campers at all mountain lakes in the North Cascades Complex would experience long-term beneficial impacts from cessation of stocking.

Under alternative D, overall impacts on backcountry users who do not fish would be beneficial related to cessation of stocking activities but adverse related to mechanical and chemical fish removal treatments. Some beneficial impacts to these visitors would occur because the number of anglers would decline over time.

Impacts on Climbers and Mountaineers

Eldorado, Forbidden, and Sahale peaks are the most popular mountaineering destinations. All lakes in the vicinity of these peaks would eventually be returned to fishless conditions, thereby reducing the amount of interaction between mountaineers and anglers. Mountaineers who fish while accessing these peaks would no longer be able to do so, but this adverse impact would be negligible because fishing is a secondary activity to mountaineering.

Mountaineers would experience long-term, negligible, beneficial impacts from cessation of fish stocking activities throughout the North Cascades Complex; however, mountaineers would be exposed to fish removal activities that may impede their backcountry experience. Rangers issuing backcountry overnight use permits would advise visitors of fish removal activities occurring at their destinations and would recommend alternate destinations. Impacts from fish removal would be short term, minor, and adverse to possibly moderate because fish removal would take many years.

Overall impacts on mountaineers under alternative D would be beneficial related to cessation of stocking activities, but mechanical and chemical lake treatment methods to return lakes to fishless conditions would result in minor to moderate long-term impacts. Any adverse impacts would be short term and avoidable.

Impacts on Stock Users and Horseback Riders

Some of the more popular fishing lakes are in the Lake Chelan National Recreation Area and accessible by horseback. Management actions for alternative D would include returning these lakes to a fishless condition. For those stock (horses, mules, llamas) users and horseback riders who also engage in sport fishing in the Lake Chelan National Recreational Area, impacts of returning lakes to a fishless condition would be long term, moderate, and adverse. For those stock users and horseback riders who do not engage in sport fishing, impacts from mechanical and chemical lake treatment activities to remove fish would be minor and adverse over the short term.

Impacts on Anglers

The majority of sport fishing in the North Cascades Complex occurs at Ross Lake and Lake Chelan, including its tributary, the Stehekin River. Implementation of this alternative is not likely to affect these visitors unless a substantial number of displaced mountain lake anglers choose to fish at Ross and

Stop for just a while—
quiet and still, and
nowhere else to be.

Chelan lakes. Sport-fishing opportunities in most of the lakes that currently contain fish would generally be eliminated within a period of 5 years. Self-sustaining (reproducing) populations of fish would be gradually removed over time. The rate of removal would depend on unpredictable changes in resource (funding and personnel) availability and differences among fish removal methods. Complete removal of self-sustaining populations of fish in some of the larger, deeper lakes might not be feasible (a feasibility analysis is provided in the "Alternatives" chapter). These lakes would continue to provide sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved.

Anglers would be affected by both long-term and shorter-term direct impacts of fish removal on the visitor experience and the permanent loss of fishing opportunity. Impacts on anglers' visitor experience from fish removal activities would be greater than impacts on other user groups because anglers may be less supportive of alternative D since it would take away their ability to fish in study area lakes.

The impacts on anglers from the eventual permanent loss of fishing opportunity in the 91 study area lakes would vary. Some casual anglers would continue to fish the backcountry lakes until the lakes became fishless. The eventual inability to fish the mountain lakes would not necessarily preclude a visit to the park for these anglers because they would still participate in other backcountry activities, such as hiking and camping, which do not involve fishing but are already part of the backcountry fishing experience.

For other anglers, fishing is the primary purpose of their visit, and in some cases, it is an activity that has been passed down for several generations. These anglers believe that fishing in the North Cascades Complex is a unique experience that cannot be duplicated elsewhere.

Overall impacts on anglers who fish in the mountain lakes in the study area would be long term, adverse, and major. It is possible that over 50% may not be satisfied with their experience, and participation in the desired activity would be greatly reduced.

Cumulative Impacts

The eventual loss of fishing opportunity under alternative D would displace some day-use and backcountry anglers to lakes outside the North Cascades Complex, including those in the national recreation areas and surrounding areas. NPS angler survey data suggest that approximately 1,000 anglers fish in mountain lakes annually (see the section titled "Visitor Use and Experience" in the "Affected Environment" chapter). For this displacement analysis, it is assumed that 50% of anglers (approximately 500 anglers per year) would be displaced from fishing in the study area lakes and may choose to fish in other mountain lakes outside of the North Cascades Complex.

There are approximately 400 lakes available for sport fishing within a 100-mile radius of the North Cascades Complex, and many of these lakes are located on adjacent U.S. Forest Service lands. The additional use of 500 anglers spread across 400 lakes would have a negligible cumulative impact on those lakes, although it is unlikely that anglers would be evenly displaced across such a broad area. A more realistic displacement scenario would involve angler displacement to relatively similar terrain found on adjacent Forest Service wilderness areas such as the Glacier Peak Wilderness. According to WDFW fishery biologists, some of the more readily accessible lakes on adjacent Forest Service lands are already overused by anglers (WDFW, B. Pfeifer, pers. comm., 2004). Additional use of these lakes by anglers displaced from the North Cascades Complex would have a cumulative adverse impact on visitor use and experience. The magnitude of impact would depend upon individual values and expectations and would range from negligible to minor.

Record flooding in October 2003 damaged or destroyed many trails and several roads in the North Cascades Complex. Most of the damage was repaired during the 2004 field season, with the upper Stehekin Valley Road being a notable exception. An environmental assessment is currently underway to evaluate alternatives for the extensively damaged road. Although the fate of the road remains uncertain for the foreseeable future, visitor use of the Stehekin Valley would be lower because road access into the valley has been greatly reduced. Reduced access to the upper Stehekin Valley, coupled with the permanent loss of fishing opportunity in that same area, would have a cumulative impact on the visitor experience that is difficult to gage at this time because the future of the road remains uncertain.

Conclusion

Adverse impacts on non-anglers under alternative D would be primarily related to the lake treatment methods. These impacts would be negligible to minor and adverse over the long term. Removal of fish from some lakes would reduce visitor use and have some long-term beneficial impacts on non-anglers seeking greater solitude in the backcountry. Impacts on most anglers overall would be minor to moderate, adverse, and long term from management actions under alternative D compared to alternative A. Major adverse impacts would occur to some anglers who believe fishing in North Cascade Complex lakes is a truly unique experience that cannot be duplicated elsewhere. Cumulative impacts related to angler displacement to overused areas outside the North Cascades Complex would overall be minor to moderate, adverse, and long term. The cumulative impact of reduced access in the Stehekin Valley due to flood damage would be minor adverse or beneficial to backcountry users.

Overall, cumulative impacts would be moderate, adverse, and long term.

SOCIAL VALUES

GUIDING REGULATIONS AND POLICIES

The *National Environmental Policy Act* requires that economic and social effects be analyzed when they are interrelated with actions that also have natural or physical effects. Economic effects are addressed in the "Socioeconomic Resources" section of this chapter. The section, "Impacts of the Alternatives on Social Values," analyzes effects on those who may or may not visit the North Cascades Complex but have expressed various points of view representing their "values" regarding the management actions proposed by the alternatives in this plan/EIS.

METHODOLOGY AND ASSUMPTIONS

Similar to the methodology used for assessing impacts on visitor use and experience, the impacts on social values are assessed given the degree to which management actions would change compared to existing management of the 91 lakes in the study area. The "Social Values" section in the "Affected Environment" chapter describes the definitions of various attitudes expressed toward wildlife management (refer to "Table 26: People's Perceptions of Animals in American Society").

This analysis is anecdotal and qualitative and based upon comments received during public scoping and the history of the fish stocking issue as documented in Louter (2003). Impacts on social values are characterized according to the simplifying assumption that "angler and angler groups" would value management actions that maintain the mountain lakes fishery, and "conservationists or conservation groups" would value management actions that would protect native ecosystems by reducing or eliminating the mountain lakes fishery. The limits of this simplifying assumption are clearly evident because social values encompass a wide spectrum of possibilities that defy discrete characterization—many anglers are conservationists, and many conservationists are anglers. Recognizing these limitations, the specific purpose of this analysis is to evaluate the impacts on social values regarding the maintenance of an artificial, nonnative recreational fishery in an NPS unit for the purpose of enhancing recreation.

Organized volunteers began stocking lakes in the 1930s.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

The study area for this analysis is the North Cascades Complex (see "Map 1" located in the envelope that accompanied this document) and the 91 naturally formed mountain lakes in the North Cascades Complex that currently have, or at one time had, a fish presence as a result of either documented or undocumented fish stocking activities. The 91 lakes addressed in this plan/EIS are scattered throughout the North Cascades Complex: 7 are in Ross Lake National Recreation Area, 15 are in Lake Chelan National Recreation Area, and 69 are located in the north and south units of North Cascades National Park (for more details, refer to the "Alternatives" chapter).

IMPACT THRESHOLD DEFINITIONS

Negligible. Impacts on views or values would not be perceptible or measurable.

Minor. Impacts on views or values would be detectable but only localized or to a small number of groups or individuals holding these values.

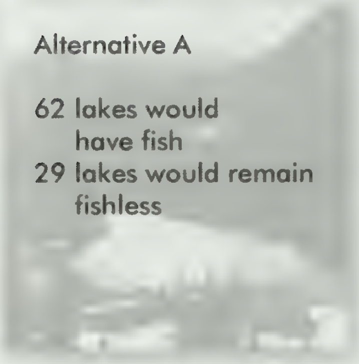
Moderate. Impacts on views or values would be detectable throughout the region (within the three counties surrounding the North Cascades Complex) or to one or more groups or numbers of individuals holding these values.

Major. Impacts on views or values would be detectable in and outside the region to larger numbers of individuals or groups holding these values.

IMPACTS OF THE ALTERNATIVES ON SOCIAL VALUES

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A would continue existing management of 91 lakes in the study area. The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter, appendix E, and "Map 1" (located in the envelope that accompanied this document).



Alternative A

62 lakes would have fish
29 lakes would remain fishless

Impacts on Social Values of Anglers and Angler User Groups

Mountain lake fishing in the North Cascades Complex follows a tradition that precedes its designation as a unit of the NPS by almost a century. Many anglers and angler user groups hold values similar to those holding conservation values. In fact, groups such as the Trail Blazers, Inc. and Washington State Hi-Lakers have assisted agencies in scientific studies and monitoring and are committed to protection of a healthy fishery.

Alternatives A provides for continued stocking of lakes in accordance with current practices. The NPS has determined that continued stocking under alternative A would require congressional action to clarify the enabling legislation to provide the NPS the authority to stock lakes in wilderness (for more information on this issue, please refer to the section titled "Implementing the Fishery Management Plan Through Congressional Action" in the "Alternatives" chapter). If Congress were to provide this authority, then the values of anglers and angler user groups would most likely not be affected because their activities would not be altered. If Congress does not act, then management actions would default to alternative D. The impacts on social values of anglers and angler user groups are defined under alternative D in this section.

Impacts on Social Values of Conservationists and Conservation Groups

In contrast to the value placed on the mountain lakes fishery by anglers who prefer the challenge and extreme scenic values found in the North Cascades Complex, many other groups and individuals believe that the mountain lakes fishery in the North Cascades Complex violates the spirit and intent of the *Wilderness Act* and the NPS conservation mission. While many anglers are also conservationists, there is a distinction between those who value the stocking of lakes for their enjoyment and those who oppose maintenance of a nonnative fishery because they place greater value on the conservation and protection of natural processes. Many of the conservation values are intertwined with wilderness values. Because the *Wilderness Act* speaks directly to specific wilderness values, that topic is addressed separately.

There has been a long-standing debate regarding the stocking of the mountain lakes and potential effects on resources in the North Cascades Complex (see the “Purpose of and Need for Action” chapter). The debate as to whether continued stocking violates *NPS Management Policies* (NPS 2001a), and whether Congress would or should sanction fish stocking, would have a continued impact to conservationists and conservation groups who oppose continued stocking and have expressed their views in and outside the region. Actions to return lakes to a fishless condition in the Sierra Nevada in California, for example, have been broadly supported by agencies, such as the U.S. Fish and Wildlife Service, and by conservation groups.

Congressional action to clarify the North Cascades Complex enabling legislation to allow for continued fish stocking would set a precedent for this NPS unit, and possibly others that have, or may have in the future, fish stocking issues. Should Congress act to clarify the North Cascades Complex enabling legislation to allow existing management practices to continue, a moderate to major adverse impact to the social values of conservationists and conservation groups would occur over the long term.

Cumulative Impacts

Continuation of management actions as described in alternative A would not alter angler use; therefore, impacts on social values of anglers would be long term and beneficial.

Continuation of management actions as described in alternative A would have a moderate to major adverse long-term cumulative impact to conservationists and conservation groups because of the perception that fish stocking and presence of fish in naturally fish-free waters is in conflict with the purposes of a national park unit. Some may feel that this would set a precedent for other agencies. Although it is unknown to what extent other agencies would continue, stop, or reduce their stocking activities in the future, the perception of such potential would influence conservationists’ perceptions on a broad scale.

Conclusion

Two Trail Blazers packing in with stocking gear.

Continuation of existing management actions under alternative A would have a beneficial effect on the social values of anglers and angler groups because stocking and sport fishing would not change. Impacts on social values of conservationists and conservation groups would be long term, moderate to major, and adverse.

Continuation of management actions as described in alternative A would not alter angler use; therefore, cumulative impacts on social values of anglers would be long term and beneficial. Continuation of management actions as described in alternative A would have a moderate to major adverse cumulative impact on conservationists and conservation groups.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

The emphasis of this alternative would be to eliminate or reduce reproducing fish populations from select lakes in the study area. Restocking of nonreproducing fish would be allowed only where biological resources would be protected. Based on best available science, some lakes would be restocked with nonreproducing fish at low densities once reproducing fish have been removed. If critical information needed to make management decisions is missing for some lakes, those lakes would not be stocked until that information becomes available. An extensive monitoring program (see appendix F) would be implemented to enable adaptive management and avoid major adverse impacts of fish on native biota.

The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

Impacts on Social Values of Anglers and Angler Groups

While alternative B would reduce angling opportunities in some lakes, the alternative also attempts to protect and enhance the mountain lakes fishery over the long term. Some anglers and groups who would be affected by the reduction of fishing opportunities either in the short term (while lakes are treated and potentially restocked) or over the long term (returning other lakes to a fishless condition), may oppose this alternative. Compared to alternative A, impacts on the social values of anglers and angler groups would be long term, minor, and adverse. However, some anglers and angler groups would also view adaptive management as beneficial. The impacts on social values of anglers and angler groups if Congress does not act to clarify the enabling legislation are described below under alternative D.

Impacts on Social Values of Conservationists and Conservation Groups

The intent of alternative B would be to enable adaptive management and minimize impacts on biological integrity (see the section titled “Adaptive Management” in the “Alternatives” chapter). While some conservationists and conservation groups may view this as a beneficial effect of this alternative, others may still oppose any efforts to continue stocking over the long term, even if lakes were restocked with nonreproducing fish and other measures were taken to minimize impacts on biological integrity. Therefore, the impact would be beneficial for some but moderate to major and adverse over the long term for others.

Cumulative Impacts

Management actions described in alternative B would alter angler use; therefore, social values of anglers would be affected. The use of the study area by anglers and the cumulative effects on angler use are described under “Impacts of Alternatives on Visitor Recreational Use” in this section. When added to the effects of this alternative, minor to moderate cumulative effects are expected, mostly related to the flooding damage to the upper Stehekin Valley Road that occurred in October 2003.

Alternative B would have a moderate to major adverse cumulative impact to conservationists and conservation groups, and some may support an adaptive management approach as defined for alternative B because of the perception that fish stocking and presence of fish in naturally fish-free waters is in conflict with the purposes of a national park unit, including national recreation areas. Some may feel this would set a precedent for other agencies. Although it is unknown to what extent other agencies would continue, stop, or reduce its stocking activities in the future, the perception of such potential would influence conservationists’ perceptions on a broad scale. Cumulative impacts on anglers and angler groups would be moderate to major, adverse, and long term compared to alternative A, although some may support the adaptive management approach, which may reduce impacts.

Conclusion

Alternative B would have a minor adverse impact on the social values of anglers and angler groups over the long term because some level of stocking and sport fishing would continue over the long term. Impacts on social values of conservationists and conservation groups would be beneficial for some who would support the new management framework, but moderate to major adverse and long term for those who oppose any stocking of lakes over the long term.

Alternative B would have a moderate to major adverse cumulative impact on conservationists and conservation groups, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts on anglers and angling groups would be moderate to major, adverse, and long term, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts related to flood damage to

the upper Stehekin Valley Road would be minor to moderate, adverse, and long term.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

The emphasis of this alternative would be to eliminate fish from (or maintain as fishless) 80 of the 91 lakes in the study area; 69 of the 80 lakes are in the national park portion of the North Cascades Complex; sport fishing would still be allowed in 9 lakes in Ross Lake and Lake Chelan National Recreation Areas. Reproducing fish populations in 2 lakes in the recreation areas would be removed, and after evaluation, the lakes may be stocked with nonreproducing trout. Sport-fishing opportunities in the national park would gradually decline over time as stocked fish populations died off and reproducing populations of fish were gradually removed, although removal of reproducing populations from the national park might not be feasible for some lakes (refer to table 7). If removal proved infeasible, these lakes would continue to provide sport-fishing opportunities for the foreseeable future. For lakes with stocked fish, after about 5 years most fish would be gone, and the quality of fishing would drop sharply (WDFW, M. Downen, pers. comm., 2004). In order to protect native biological resources, alternative C would focus on reducing or eliminating reproducing fish in the lakes located in the national recreation areas. Sport fishing in the national recreation areas would still be allowed, although reproducing populations of fish would be removed, and in some cases, the lakes would be restocked with trout that are incapable of reproducing. Management actions to remove reproducing fish populations would proceed at a rate governed by the availability of funding and personnel.

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter and appendix E.

Impacts on Social Values of Anglers and Angler Groups

The number of lakes available for angler use in alternative C, compared to alternative A, would be greatly reduced, with fishing in the national park portion of the North Cascades Complex eventually eliminated over time. Angling opportunities would be limited to select lakes in the national recreation areas (see the "Impacts of Alternatives on Visitor Use and Experience" section of this chapter). While sport fishing would continue to some degree in the national recreation areas, anglers who value fishing in the high mountain lakes in the national park portion of North Cascades Complex would experience a moderate to major adverse impact over the long term. The impact on social values of anglers and groups should Congress not enact a change to the enabling legislation is described under alternative D.

Impacts on Social Values of Conservationists and Conservation Groups

While the number of lakes available for stocking world be reduced in alternative C compared to alternative A, some conservationists and conservation groups may still view stocking as inappropriate; others might view this as a legitimate compromise. This is because *NPS Management Policies* regarding fish stocking contain several exceptions, one of which pertains to lakes that have previously been stocked in recreation areas (NPS 2001a, 4.4.3). The impact on conservationists and conservation groups would be beneficial for some but moderate to major adverse and long term for others.

Cumulative Impacts

Management actions described in alternative C would alter angler use; therefore, social values of anglers and angler groups would be affected. The use of study area lakes by anglers and the cumulative effects on angler use is described under "Impacts of the Alternatives on Visitor Recreational Use" in this section. When added to the effects of this alternative, minor to moderate cumulative effects are expected and mostly related to the flooding damage to the upper Stehekin Valley Road that occurred in October 2003.

Alternative C would have a moderate to major adverse long-term cumulative impact on conservationists and conservation groups because of the perception that fish stocking and presence of fish in naturally fish-free waters is in conflict with the purposes of a national park unit, including national recreation areas. Some may feel that this would set a precedent for other agencies. Although the extent to which other agencies would continue, stop, or reduce its stocking activities in the future is unknown, the perception of such potential would influence conservationists' perceptions on a broad scale.

Conclusion

Alternative C would have a moderate to major adverse impact on the social values of anglers and angler groups over the long term because sport fishing would eventually be eliminated in the national park, and many anglers and angler groups believe that fishing in the park is a unique opportunity that cannot be duplicated elsewhere. Impacts on social values of conservationists and conservation groups would be beneficial for some who would support the new management framework but moderate to major adverse and long term for those who oppose any stocking of lakes over the long term.

Alternative C would have a moderate to major adverse cumulative impact on conservationists and conservation groups, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts on anglers and angling groups would be moderate to major, adverse, and long term, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts related to flood damage to the upper Stehekin Valley Road would be minor to moderate, adverse, and long term.

Alternative D: 91 Lakes Would Be Fishless

Alternative D

91 lakes would be fishless

Under alternative D, the goal would be to remove fish from 62 of the 91 lakes in the study area, with 29 lakes remaining fishless. Sport-fishing opportunities in most of these lakes would generally be eliminated within a period of 5 years. Self-sustaining (reproducing) populations of fish would gradually be removed over time. The rate of removal would depend on unpredictable changes in resource (funding and personnel) availability and differences among fish removal methods. Complete removal of self-sustaining fish populations in the 9 larger, deeper lakes identified in table 7 might not be feasible. These lakes would continue to provide sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved. Congressional action would not be required to implement this alternative.

The “Alternatives” chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the “Alternatives” chapter and appendix E.

Impacts on Social Values of Anglers and Angler Groups

Elimination of sport fishing in the 91 lakes would have a moderate to major adverse impact on social values of anglers and angler groups.

Impacts on Social Values of Conservationists and Conservation Groups

Overall, the impact on social values of conservationists and conservation groups would be beneficial.

Cumulative Impacts

Management actions described in alternative D would substantially alter angler use; therefore, social values of anglers and angler groups would be affected. The use of the study area by anglers and the cumulative effects on angler use is described under “Impacts of the Alternatives on Visitor Recreational Use” in this section. When added to the effects of this alternative, moderate to major adverse, long-term cumulative effects are expected.

Alternative D would have a beneficial cumulative impact on conservationists and conservation groups over the long term.

Conclusion

Alternative D would have a moderate to major adverse impact on the social values of anglers and angler groups over the long term, especially for those who use and value the park for this experience. Anglers may choose to pursue sport fishing outside the North Cascades Complex. Overall, impacts on social values of conservationists and conservation groups would be beneficial.

Alternative D would have a moderate to major adverse cumulative impact on conservationists and conservation groups, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts on anglers and angling groups would be moderate to major, adverse, and long term, but some may support the adaptive management approach, which may reduce impacts to some degree. Cumulative impacts related to flood damage to the upper Stehekin Valley Road would be minor to moderate, adverse, and long term.

WILDERNESS VALUES

GUIDING REGULATIONS AND POLICIES

The *Washington Park Wilderness Act of 1988* (WPWA) established 93% of the North Cascades Complex as the Stephen T. Mather Wilderness and directed the NPS to manage the wilderness in accordance with the *Wilderness Act of 1964*. The *Wilderness Act*, passed on September 3, 1964, "provides a degree of protection to the resources of the National Park System that the National Park Service Organic Act does not" (NPS 1999c). The House Report accompanying the Act, which helps to clarify Congressional intent with respect to the Act, states that its purpose is to establish a National Wilderness Preservation System made up of designated wilderness areas, "because of the undeveloped character of their lands and the need to protect and manage them in order to preserve, as far as possible, the natural conditions that now prevail" (House Report No. 1538, at 7, 88th Congress, 2nd session [July 2, 1964]). The section titled "Wilderness Values" in the "Affected Environment" chapter further describes the *Wilderness Act*, the legislation that created the wilderness areas in the North Cascades Complex, and the wilderness characteristics and values specific to the Stephen T. Mather Wilderness in the North Cascades Complex.

Anthropocentric: This perspective emphasizes human use and enjoyment of wilderness.

METHODOLOGY AND ASSUMPTIONS

The analyses of impacts on wilderness values is qualitative and based upon comments received during public scoping, the history of the issue as documented in Louter (2003), and review of literature regarding wilderness values of the American public.

The magnitude and intensity of impacts on wilderness values greatly depends upon individual perspectives. Those engaged in wilderness management have found it useful to characterize impacts on wilderness values according to two alternative philosophical perspectives on wilderness: anthropocentric and biocentric. The *anthropocentric* perspective emphasizes human use and enjoyment of wilderness. The *biocentric* perspective emphasizes protection and maintenance of natural processes and conditions (Hendee and Stankey 1973). According to Hendee and Dawson (2002), the alternative labels—*anthropocentric* and *biocentric*—can "create a false distinction between wilderness 'for people's sake' and wilderness 'for nature's sake.'" This analysis is not intended to perpetuate these distinctions, nor is it intended to argue that either perspective is right or wrong. Use of the *anthropocentric* and *biocentric* concepts is merely a convenient way of describing how fishery management actions would impact wilderness values according to different perspectives.

Biocentric: This perspective emphasizes protection and maintenance of natural processes and conditions.

"You must teach your children that the ground beneath their feet is the ashes of our grandfathers. So that they will respect the land, tell your children that the earth is rich with the lives of our kin . . . all things are connected."

attributed to Chief Seattle

This impact section focuses on the enduring wilderness values implicit in the *Wilderness Act* that visitors can experience when visiting the Stephen T. Mather Wilderness; those values are

> opportunities for solitude
>
> opportunities for primitive, unconfined forms of recreation (for example, the freedom for visitors to pursue nonmotorized recreational activities such as hiking, climbing, and sport fishing)
>
> naturalness, or the prevalence of natural conditions with little evidence of human impact or manipulation of natural conditions

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

The study area for this analysis includes the Stephen T. Mather Wilderness, which makes up 93% of the North Cascades Complex (see “Map 1” located in the envelope that accompanied this document). For more details, refer to the “Alternatives” chapter.

Members of the public who may potentially be affected include wilderness users who would experience firsthand the potential impacts on wilderness values during their wilderness visit. There are other members of the public, however, that might never visit the Stephen T. Mather Wilderness and would never experience impacts on wilderness values firsthand, but they would still be impacted simply by knowing that various fishery management actions were occurring.

IMPACT THRESHOLD DEFINITIONS

Negligible. Fishery management actions would have no discernable impact on opportunities for solitude. Opportunities for primitive and unconfined forms of recreation would essentially remain unchanged. Natural conditions would prevail with little evidence of human manipulation. The wilderness area would be affected primarily by the forces of nature. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation.

Minor. Fishery management actions would have a slightly beneficial or adverse impact on opportunities for solitude in limited areas of the wilderness. Opportunities for primitive and unconfined forms of recreation would be slightly improved or reduced in limited areas of the wilderness. Natural conditions would predominate, though human-caused impacts (either beneficial or adverse) on the natural environment would be slightly detectable in limited areas of the wilderness.

Moderate. Fishery management actions would have a readily apparent, beneficial or adverse impact on opportunities for solitude in limited areas of the wilderness. Opportunities for primitive and unconfined forms of recreation would be noticeably improved or reduced in limited areas of the wilderness. Natural conditions would predominate, though human-caused impacts (either beneficial or adverse) on the natural environment would be readily apparent in limited areas of the wilderness.

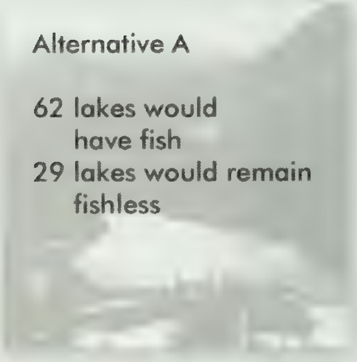
Major. Fishery management actions would have a readily apparent beneficial or adverse impact on opportunities for solitude throughout the wilderness area. Opportunities for primitive and unconfined forms of recreation would be substantially improved or reduced throughout the wilderness area. Human-caused impacts (either beneficial or adverse) on the natural environment would be readily apparent throughout the wilderness.

Impairment. Impairment would occur when the wilderness resources have been substantially altered, eliminating the characteristics that meet the criteria for consideration and classification as wilderness. Criteria for determining classification as wilderness can be found in *NPS Management Policy 6.2.1, Assessment of Wilderness Suitability or Nonsuitability* (NPS 2001a).

IMPACTS OF THE ALTERNATIVES ON WILDERNESS VALUES

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

The current mountain lakes fishery management activities at the North Cascades Complex would continue under the no-action alternative. The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.



Alternative A

62 lakes would have fish
29 lakes would remain fishless

The mountain lakes fishery management actions under alternative A that would directly affect wilderness values include stocking and related activities and very limited monitoring. The mountain lakes fishery would indirectly affect visitor use of lakes by providing fishing opportunities. Maintenance of the mountain lakes fishery would continue to affect the naturalness of the wilderness by manipulating natural processes to maintain an artificial recreational fishing opportunity.

Impacts on Opportunities for Solitude

Under alternative A, stocking of select lakes in the park and national recreation areas would continue in accordance with established practices. Most lakes would continue to be backpack stocked, which would occur very infrequently at a given lake, and the stocking activity would generally be limited to a few individuals. Therefore, backpack stocking would have a negligible direct short- and long-term impact on visitor solitude. Fixed-wing aircraft would be used as a method to stock lakes that could not be backpack stocked. Aircraft stocking would markedly disrupt visitor solitude along the flight path of the aircraft and especially above the lakes being stocked. The duration of impact, however, would be very brief (about a minute over a given lake every few years for each lake stocked) and very infrequent. Given the short-term and infrequent nature of aircraft stocking, there would be a minor adverse short- and long-term impact on opportunities for solitude.

Sport-fishing opportunities in the park and national recreation areas would remain at current levels. Continued stocking would provide opportunities for sport fishing and indirectly impact the solitude of other backcountry visitors such as hikers, climbers, or stock (horses, mules, llamas) users.

It is estimated that about 1,000 anglers currently fish the mountain lakes each year. Table 22 in the "Affected Environment" chapter shows that the average annual visitation to the North Cascades Complex from 1996 to 2002 was about 412,012 people. Table 24 shows that fishing in all North Cascades Complex waters (streams, rivers, reservoirs, ponds, mountain lakes) accounts for 11.5% of total visitor use. Backcountry use permit data for 2003 show that 4,035 visitors were issued backcountry overnight use permits, and that roughly 10.5% (424) of visitors who were issued permits were planning on fishing at study area lakes (62 of these lakes currently have fish). A 2003 survey of day-use visitors shows that approximately 75 day users were engaged in fishing at the most accessible day-use lakes in the study area. The estimate of 1,000 anglers who currently fish the study area lakes each year is derived from the backcountry permit data and the 2003 survey data (the estimate takes into account incomplete sampling due to dispersed access, highly variable and broad times of entry and departure, and purposeful or inadvertent avoidance of backcountry permit registrations).

These statistics indicate that angler use is a relatively small portion of overall wilderness use, and it is spread across a very wide area. Many of the lakes that contain stocked or self-sustaining populations of fish are located in untrailed or cross-country portions of the wilderness that receive very little use (refer to "Map 2" and "Map 2 Table"). Opportunities for solitude would remain negligibly impacted in these areas of the wilderness that receive very little use over the long term. Some fishable lakes, however, are located in relatively high-use areas. Continuing to provide sport-fishing opportunities (through stocking or benign neglect of reproducing fish populations) at these lakes would continue angling and reduce opportunities for solitude. In these areas, continuing to provide sport-fishing opportunities would have a minor, adverse impact on opportunities for solitude over the long term.

Impacts on Opportunities for Primitive Recreation

Fishing opportunities throughout the wilderness would remain at current levels. Continued angler use of these areas would affect recreational use by non-anglers. Most of the lakes in the North Cascades Complex are located in untrailed portions of the wilderness that receive very low use by hikers, climbers, and other non-anglers. Some fishable lakes, however, are located in areas with relatively high use. Continuing to provide sport-fishing opportunities at these lakes may displace other recreational activities during summer high-use periods by limiting the number of permits available for other users. Impacts to other visitors' opportunities for primitive recreation in high-use areas over the summer would be minor to moderate adverse over the long term. It is noted that some illegal stocking has occurred in the past and may continue to occur under alternative A. It is impossible to quantify the degree to which illegal stocking has occurred or may occur.

Impact on Naturalness

Continuing the current management of the mountain lakes fishery would allow self-sustaining and stocked populations of fish to persist. These actions would perpetuate the existence of a nonnative, artificial fishery in lakes that were naturally fish free and would therefore diminish the value of naturalness in the Stephen T. Mather Wilderness. The magnitude of the impact would depend upon individual perception and experience.

Some wilderness users would not be aware that fish were even present in the lakes. Some visitors might notice the fish but not realize they were nonnative and may react indifferently. The impacts on the wilderness value of naturalness for these visitors would be negligible over the long term with regard to fishery management because they would encounter what they perceive to be "pristine" natural conditions in most of the wilderness. Those with anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience negligible long-term impacts under alternative A.

On the other hand, some informed wilderness users would be aware of nonnative fish in the lakes due to stocking. They would also experience the indirect effects of angling, such as social trails along lakeshores, fire rings, and lost or discarded fishing tackle and equipment. The magnitude of adverse impact would vary among individuals. Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience major, long-term adverse impacts from the continued fishery management practices under alternative A.

Some people would not even have to experience these impacts firsthand to be adversely affected. Without ever visiting the North Cascades Complex, these individuals would be adversely impacted simply by knowing that the naturalness of the North Cascades Complex was being impacted by the current mountain lakes fishery management practices. The magnitude of impact is unknown.

Cumulative Impacts

The flooding in October 2003 destroyed most of the upper portion of the Stehekin Valley Road. For the foreseeable future, access to various portions of the Stehekin Valley may take much longer and may exclude some visitors from accessing portions of the area. Most mountain lake anglers are used to hiking long distances, often off trail, to access lakes, so the cumulative impact on mountain lake fishing opportunities from reduced access would likely be negligible over the short and long terms.

Stocked and reproducing populations of fish would remain in wilderness lakes throughout the region, including the study area lakes in the Stephen T. Mather Wilderness in the North Cascades Complex. This would be a major, long-term adverse cumulative impact on those who believe that continued stocking, as

proposed under alternative A, in wilderness and benign neglect of reproducing populations of fish would compromise natural processes. This would be a long-term negligible cumulative impact on those who believe that human use and enjoyment of wilderness should continue.

Conclusion

Backpack stocking would have a direct short- and long-term negligible impact on visitor solitude. Given the short-term and infrequent nature of fixed-wing aircraft stocking, there would be a short- and long-term minor adverse impact on opportunities for solitude. Sport-fishing opportunities would remain at current levels. This would result in long-term negligible adverse impacts on opportunities for solitude for those areas that receive relatively little use, and long-term, minor adverse impacts on opportunities for solitude for those areas that receive high use.

Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be minor to moderate adverse over the long term.

Those with anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience long-term negligible impacts under alternative A. Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience long-term major adverse impacts by the continued fishery management practices under alternative A. Impacts on wilderness users who are not aware that fish are present in the lakes would be negligible over the long term.

Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms.

There would be a major, long-term adverse cumulative impact on those who believe that continued stocking and continued presence of reproducing fish populations under alternative A would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and enjoyment of wilderness should continue.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

The emphasis of this alternative would be to eliminate self-sustaining (reproducing) populations of fish from select lakes in the study area. Restocking of nonreproducing fish would be allowed in select lakes provided biological integrity would be conserved. Stocking of low densities of fish incapable of reproducing would be allowed to continue in select lakes. Stocking would be discontinued in lakes where data are currently lacking to make informed management decisions. A monitoring program (see appendix F) would be implemented in order to enable adaptive management of lakes.

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

Impacts on Opportunities for Solitude

Compared to alternative A, fewer lakes in the national park and national recreation areas would be stocked. Most lakes would continue to be backpack stocked, which would occur very infrequently at a given lake, and the stocking activity would generally be limited to a few individuals; therefore, stocking would continue to have a negligible direct impact on visitor solitude over the long term. Fixed-wing aircraft would be used as a method to stock lakes that would not be backpack stocked, although fewer lakes would be stocked via aircraft compared to alternative A. Aircraft stocking would markedly disrupt visitor solitude along the flight path of the aircraft and especially above the lakes being stocked. The duration of impact, however, would be very brief (about a minute over a given lake) and very infrequent (once every few years). Given the short-term and infrequent nature of fixed-wing aircraft stocking, there would be a minor adverse short- and long-term impact on opportunities for solitude under alternative B.

Management actions related to fish removal include the use of chemical treatments (piscicides) and mechanical treatments, which would require the use of helicopters, motorized boats, electrofishing gear, gillnetting, and the routine presence of crews at select lakes. Gillnetting and piscicide application would require use of a helicopter to ferry heavy gear and the use of electrofishing gear to supplement netting. Piscicide use would be limited to one lake at time and probably only one or two lakes would be treated per season. Gillnetting would occur at several lakes at one time, depending on the availability of personnel and equipment. The noise and visual disturbance from these management actions would affect the solitude at lakes undergoing treatment and in areas along the flight path of helicopters or the access routes. Helicopter use would be limited to a few flights in a few locations over the course of a season. To minimize impacts on visitor solitude, NPS staff issuing backcountry overnight use permits would encourage users to visit areas not undergoing fish removal actions. Taken together, the impacts on solitude from fish removal activities would be long term minor to moderate adverse because most of the wilderness would remain unaffected by fish removal actions.

Fishery management actions would reduce sport-fishing opportunities in the national park and national recreation areas compared to alternative A. Opportunities for solitude would be even greater in these areas because there would be fewer anglers present to disrupt the solitude of other wilderness users. This would be a long-term minor beneficial impact. Some lakes in certain high-use areas would remain fishable. Continuing to provide sport-fishing opportunities (through stocking or where removal of self-sustaining fish populations may not be feasible) at these lakes would encourage angling and impact other users' opportunities for solitude. In these areas, continuing to provide sport-fishing opportunities would have a minor adverse impact on opportunities for solitude over the long term.

Impacts on Opportunities for Primitive Recreation

Over time, many lakes with self-sustaining populations or stocked populations of fish would become fishless, and the overall opportunity for fishing in the wilderness would be reduced compared to alternative A. Loss of fishing opportunity would have an adverse impact on mountain lake anglers. Some anglers may simply fish elsewhere. Impacts on these anglers would be minor and long term. Other anglers believe that the lakes in North Cascades Complex offer a unique fishing opportunity that cannot be duplicated elsewhere; these anglers would experience major adverse impacts over the long term from lost fishing opportunities.

Continued angler use of lakes that remain fishable may limit the available backcountry overnight permits for other wilderness users. Most of the lakes in the North Cascades Complex are located in untrailed portions of the wilderness that receive very low use by hikers, climbers, and other non-anglers (refer to "Map 2" and "Map 2 Table"). Some fishable lakes, however, are located in areas that experience relatively high use. Compared with alternative A, angler use would become more concentrated at certain lakes that remain fishable. Continuing to provide sport-fishing opportunities (through stocking or where removal of self-sustaining populations may not be feasible) at these lakes would displace other recreational activities during summer high-use periods by limiting the number of permits available for other users. Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be minor to moderate adverse over the long term. It is noted that some illegal stocking has occurred in the past and may continue to occur under alternative B. It is impossible to quantify the degree to which illegal stocking has or may occur.

Impacts on Naturalness

Management of the mountain lakes fishery under alternative B would allow stocked populations of fish to persist. These actions would perpetuate the existence of a nonnative, artificial fishery in mountain lakes that were naturally fish free and would therefore diminish the value of naturalness in the Stephen T. Mather Wilderness. The magnitude of the impact would depend upon individual perception and experience.

Some wilderness users would not be aware that fish were even present in the lakes. Some visitors might notice the fish but not realize they were nonnative and may react indifferently. The impacts on the wilderness value of naturalness for these visitors would be negligible over the long term with regard to fishery management because they would encounter what they perceive to be "pristine" natural conditions in most of the wilderness. Those with anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience negligible long-term impacts under alternative B. Some individuals with an anthropocentric perspective would view the application of a science-based adaptive management plan as a negligible impact, and some would view this as beneficial.

On the other hand, some informed wilderness users would be aware of nonnative fish in the lakes due to stocking. They would also experience the indirect effects

of angling, such as social trails along lakeshores, fire rings, and lost or discarded fishing tackle and equipment. The magnitude of adverse impact would vary among individuals. Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience major, long-term adverse impacts from the fishery management actions proposed under alternative B. Some with a biocentric perspective would view the application of a science-based adaptive management plan as beneficial.

Some people would not even have to experience these impacts firsthand to be adversely affected. Without ever visiting the North Cascades Complex, these individuals would be adversely impacted by simply knowing that the naturalness of the North Cascades Complex was being impacted by mountain lakes fishery management actions proposed under alternative B. The magnitude of impact is unknown.

Cumulative Impacts

The flooding in October 2003 destroyed most of the upper portion of the Stehekin Valley Road. For the foreseeable future, access to various portions of the Stehekin Valley may take much longer and may exclude some visitors from accessing portions of the area. Most mountain lake anglers are used to hiking long distances, often off trail, to access lakes, so the cumulative impact on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long term.

Stocked and some reproducing populations of fish would remain in wilderness lakes throughout the region, including the study area lakes in the Stephen T. Mather Wilderness in the North Cascades Complex. This would be a major, long-term adverse cumulative impact on those who believe that continued stocking (as proposed under alternative B) in wilderness and continued presence of reproducing populations of fish would compromise natural processes. There would be a long-term negligible cumulative impact on those who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles in wilderness areas, cumulative impacts either would be beneficial or adverse over the long term. Fishery management actions, especially fish removal, would impose an administrative presence in wilderness, in addition to established administrative actions such as research and monitoring, ranger patrols, and fire management actions. Taken together, these additional fishery management actions would have a minor, adverse cumulative impact on solitude over the long term.

Conclusion

Backpack stocking would have a negligible direct impact on visitor solitude over the long term. Given the short-term and infrequent nature of fixed-wing aircraft stocking, there would be a short- and long-term minor adverse impact on opportunities for solitude. Fishery management actions would reduce sport-fishing opportunities in the national park and national recreation areas compared to alternative A. This would result in a long-term minor beneficial impact on opportunities for solitude in some areas. However, select lakes in certain high-use areas would remain fishable, resulting in minor adverse impacts on opportunities for solitude over the long term. The impacts on solitude from fish removal activities would be minor to moderate and adverse over the long term.

Anglers who choose to fish elsewhere due to reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience long-term major adverse impacts. Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be minor to moderate adverse over the long term.

Those with anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience long-term negligible impacts under alternative B. Some of those with an anthropocentric perspective would view the application of a science-based adaptive management plan as a negligible impact, and some would view this as beneficial. Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience long-term major adverse impacts from fishery management actions under alternative B. Some with biocentric perspectives would view the application of a science-based adaptive management plan as beneficial over the long term. Impacts on wilderness users who are not aware that fish are present in the lakes would be long term and negligible.

Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms.

There would be a long-term major adverse cumulative impact on those who believe that the continued stocking (as proposed under alternative B) in wilderness and continued presence of reproducing populations of fish would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles in wilderness areas, cumulative impacts would be long-term beneficial or adverse. Fishery management actions, including fish removal, would have long-term minor adverse cumulative impacts on solitude.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

The emphasis of this alternative would be to discontinue stocking fish in the national park portion of the North Cascades Complex and remove all self-sustaining (reproducing) populations of fish, where feasible. Stocking of nonreproducing fish in select lakes in the national recreation areas would be allowed provided biological integrity would be conserved. Some lakes in the national recreation areas would continue to be stocked, though stocking would be discontinued in lakes where data are currently lacking to make informed management decisions. A monitoring program (see appendix F) would be

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

implemented in order to enable adaptive management of lakes in the national recreation areas.

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter and appendix E.

Impacts on Opportunities for Solitude

No lakes in the national park portion of the North Cascades Complex would be stocked. Select lakes in the national recreation areas would continue to be backpack stocked, which would continue to have a long-term negligible direct impact on visitor solitude. Fixed-wing aircraft would be used as a method to stock lakes that would not be backpack stocked, although fewer lakes would be stocked via aircraft compared to alternatives A and B. Aircraft stocking would markedly disrupt visitor solitude along the flight path of the aircraft and especially above the lakes being stocked. The duration of impact, however, would be very brief (about a minute over a given lake) and very infrequent (every few years for each lake stocked). Given the short-term and infrequent nature of aircraft stocking, there would be a short- and long-term minor adverse impact on opportunities for solitude.

The management actions related to fish removal would be similar to alternative B; however, more lakes would be subjected to fish-removal activities under alternative C. The impacts on solitude from fish removal actions would be short-term minor to moderate adverse because most of the wilderness would remain unaffected by fish removal actions at any one time.

Sport-fishing opportunities in national park lakes would eventually be eliminated, except in larger, deeper lakes where complete fish removal might not be feasible (refer to table 7). Sport fishing would continue in select national recreation area lakes. Compared with alternatives A and B, opportunities for solitude would be even greater in the North Cascades Complex, over time, because fewer lakes would be available for fishing. This would have a moderate beneficial impact on solitude in these areas over the long term. Some lakes in certain high-use areas in the national recreation areas would remain fishable, and continuing to provide sport-fishing opportunities would have a minor adverse impact on opportunities for solitude over the long term.

Impact on Opportunities for Primitive Recreation

Loss of fishing opportunity in the national park would have an adverse impact on mountain lake anglers. Some anglers may simply fish elsewhere. Impacts on these anglers would be minor and long term. Other anglers believe that the lakes in North Cascades Complex offer a unique fishing opportunity that cannot be duplicated elsewhere; these anglers would experience long-term, major adverse impacts from lost fishing opportunities.

Continued angler use of lakes that remain fishable under alternative C may limit the available backcountry overnight permits for other wilderness users. Some fishable lakes in the national recreation areas are located in areas receiving relatively high use. Angler use would become more concentrated at certain lakes that remain fishable. Continuing to provide sport-fishing opportunities (through stocking or where removal of self-sustaining populations may not be feasible) at these lakes may displace other recreational activities during summer high-use periods by limiting the number of permits available for other users. Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be minor to moderate adverse over the long term. It is noted that some illegal stocking has occurred in the past and may continue to occur under alternative C, although it is impossible to quantify the degree to which illegal stocking has occurred or may occur in the future. Sport fishing is very important to many wilderness enthusiasts. Some mountain lake anglers believe that current mountain lake fishing opportunities are limited compared to the past. These anglers believe, to varying degrees, that many other lakes in the North Cascades Complex should be fishable. Compared with alternatives A and B, fishing opportunities would be further reduced, and this would have a major, adverse impact on these anglers.

Impacts on Naturalness

Management of the mountain lakes fishery under alternative C would allow stocked populations of fish to persist in select lakes in the national recreation areas and in nine lakes in the national park where complete fish removal may not be feasible (refer to table 7 in the "Alternatives" chapter). These actions would perpetuate the existence of a nonnative, artificial fishery in mountain lakes that were naturally fish free and would therefore diminish the value of naturalness in the Stephen T. Mather Wilderness. The magnitude of impact would depend upon individual perception and experience.

Similar to alternatives A and B, some wilderness users would not be aware that fish were even present in the stocked lakes. Some visitors might notice the fish but not realize they were nonnative and may probably react indifferently. The impacts on the wilderness value of naturalness for these visitors would be negligible with regard to fishery management because they would encounter what they perceive to be "pristine" natural conditions in most of the wilderness.

Those with an anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience long-term moderate adverse impacts under alternative C due to the loss of fishable lakes in the national park; however, fishing opportunities would still remain in wilderness areas in the national recreation areas. Some of those with an anthropocentric perspective would view the application of a science-based adaptive management plan as a negligible impact, and some would view this as beneficial over the long term.

On the other hand, some informed wilderness users would be aware of nonnative fish in the lakes due to stocking. They would also experience the indirect impacts of angling, such as social trails along lakeshores, fire rings, and lost or discarded fishing tackle and equipment. The magnitude of adverse impact would vary among individuals. Those with strong biocentric views of wilderness would continue to experience long-term major adverse impacts from continued stocking of fish in the national recreation area lakes. Some with a biocentric perspective would view the application of a science-based adaptive management plan as beneficial over the long term.

Some people may not have to experience these impacts firsthand to be adversely affected. Without ever visiting the North Cascades Complex, these individuals would be adversely impacted simply by knowing that the naturalness of the North Cascades Complex was being impacted by fishery management actions under alternative C. The magnitude of impact is unknown.

Cumulative Impacts

The flooding in October 2004 destroyed most of the upper portion of the Stehekin Valley Road. For the foreseeable future, access to various portions of the Stehekin Valley may take much longer and may exclude some visitors from accessing portions of the area. Most mountain lake anglers are used to hiking long distances, often off trail, to access lakes, so the cumulative impact on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms.

Stocked and some reproducing populations of fish would remain in national recreation area lakes and potentially some national park lakes where complete fish removal may not be feasible (refer to table 7 in the “Alternatives” chapter). This would be a long-term major adverse cumulative impact for those who believe that the continued stocking (as proposed under alternative C) in wilderness and continued presence of reproducing populations of fish would compromise natural processes. There would be a long-term negligible cumulative impact on those who believe that human use and enjoyment of wilderness should continue. Depending on one’s views regarding the application of science-based adaptive management principles in wilderness areas, cumulative impacts either would be beneficial or adverse over the long term. Fishery management actions, especially fish removal, would impose an administrative presence in wilderness, in addition to established administrative actions such as research and monitoring, ranger patrols, and fire management actions. Taken together, these additional fishery management actions would have a minor adverse cumulative impact on solitude over the long term.

Compared to alternatives A and B, there would be long-term moderate beneficial cumulative impacts on wilderness values due to the cessation of stocking and removal of fish from the study area lakes in the national park.

Conclusion

Backpack stocking would have a negligible direct impact on visitor solitude over the long term. Given the short-term and infrequent nature of fixed-wing aircraft stocking, there would be a short- and long-term minor adverse impact on opportunities for solitude. Sport-fishing opportunities would be eliminated, where feasible, in the national park lakes and would continue to exist in select national recreation area lakes. This would result in a moderate beneficial impact on opportunities for solitude over the long term in some areas. However, some lakes in certain high-use areas would remain fishable, resulting in minor adverse impacts on opportunities for solitude over the long term. The impacts on solitude from fish-removal activities would be minor to moderate and adverse over the long term.

Anglers who choose to fish elsewhere due to the reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience long-term major adverse impacts. Impacts on other visitors' opportunities for primitive recreation in high-use areas over the summer would be minor to moderate adverse over the long term.

Those with an anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience long-term moderate adverse impacts under alternative C due to the loss of fishable lakes in the national park; however, fishing opportunities would still remain in wilderness areas in the national recreation areas. Some of those with an anthropocentric perspective would view the application of a science-based adaptive management plan as a negligible impact, and some would view this as beneficial over the long term. Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience long-term major adverse impacts from the fishery management actions under alternative C. Some with biocentric perspectives would view the application of a science-based adaptive management plan as beneficial over the long term. Impacts are wilderness users who are not aware that fish are present in the lakes would be negligible over the long term.

Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms.

There would be a long-term major adverse cumulative impact on those who believe that the stocking proposed under alternative C and continued presence of reproducing populations of fish would compromise natural processes in wilderness. There would be long-term negligible cumulative impacts on those who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles in wilderness areas, cumulative impacts either would be beneficial or adverse over the long term. Fishery management actions, including fish removal, would have long-term minor adverse impacts on solitude. Due to the cessation of stocking in the national park, moderate beneficial cumulative impacts would be expected on wilderness values over the long term.

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

Alternative D would eventually eliminate the mountain lakes fishery in the North Cascades Complex. The "Alternatives" chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the "Alternatives" chapter and appendix E.

Alternative D

91 lakes would
be fishless

Impacts on Opportunities for Solitude

All stocking in the North Cascades Complex would cease. Compared to alternative A, this would cause moderate to major beneficial impacts on opportunities for solitude over the long term due to the decreased use of high mountain lakes for fishing.

Management actions related to fish removal include the use of chemical treatments (piscicides) and mechanical treatments, which would require the use of helicopters, motorized boats, electrofishing gear, gillnetting, and the routine presence of crews at select lakes. Gillnetting and piscicide application would require use of a helicopter to ferry heavy gear and the use of electrofishing gear to supplement netting. Removal with piscicides would be limited to one lake at time and probably only one or two lakes would be treated per season. Gillnetting would occur at several lakes at one time, depending on the availability of personnel and equipment. The noise and visual disturbance from these management actions would affect the solitude at lakes undergoing treatment and in areas along the flight path of helicopters or the access routes. Helicopter use would be limited to a few flights in a few locations over the course of a season. To minimize impacts on visitor solitude, NPS staff issuing backcountry overnight use permits would encourage users to visit areas not undergoing fish-removal actions. Taken together, the impacts on solitude from fish removal activities would be long term, minor to moderate adverse because most of the wilderness would remain unaffected by fish-removal actions.

Fishery management actions would eliminate sport-fishing opportunities in the study area lakes; however, fishing opportunities would be available in the foreseeable future while lake treatment activities were completed. In addition, fishing opportunities would still remain in the reservoirs, rivers, and some streams throughout the North Cascades Complex.

Compared to alternative A, opportunities for solitude would increase in the wilderness because there would be fewer anglers present to disrupt the solitude of other wilderness users. This would be a long-term moderate to major beneficial impact. Fishing opportunities would be available in the nine large, deep lakes identified in table 7 where complete fish removal may not be feasible. Near those nine lakes, sport-fishing activities would affect opportunities for solitude, and this would result in a minor adverse impact over the long term for some visitors.

Impacts on Opportunities for Primitive Recreation

Over time, all lakes with self-sustaining populations or stocked populations of fish would become fishless, and the overall opportunity for fishing in the wilderness would be eliminated. Compared to alternative A, loss of fishing opportunity would have a major adverse impact on mountain lake anglers. Some anglers may simply fish elsewhere, and impacts on these anglers would be long term and minor. Other anglers believe that the lakes in North Cascades Complex offer a unique fishing opportunity that cannot be duplicated elsewhere; these anglers would experience long-term major adverse impacts from lost fishing opportunity. It is noted that some illegal stocking has occurred in the past and may continue to occur under alternative D, although it is impossible to quantify the degree to which illegal stocking has occurred or may occur in the future.

The cessation of anglers fishing at lakes in the Stephen T. Mather Wilderness would result in long-term beneficial impacts on other visitors because it may increase the availability of backcountry overnight use permits.

Impacts on Naturalness

Alternative D would remove all fish from the 62 study area lakes that currently contain fish. These actions would eliminate, where feasible, the existence of a nonnative, artificial fishery in mountain lakes that were naturally fish free and would therefore restore the value of naturalness in the Stephen T. Mather Wilderness. The magnitude of the impact would depend upon individual perception and experience.

Some wilderness users would not be aware that fish were removed from the lakes. The impacts on the wilderness value of naturalness for these visitors would be negligible over the long term. Those with an anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience major long-term adverse impacts under alternative D. Some of those with an anthropocentric perspective would view the application of a science-based adaptive management plan to remove fish as a negligible impact, and some would view this as beneficial.

On the other hand, some informed wilderness users would be aware that fish had been removed. They would no longer experience the indirect effects of angling, such as social trails along lakeshores, fire rings, and lost or discarded fishing tackle and equipment. The magnitude of impact would vary among individuals. Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience major long-term beneficial impacts because all fish would be removed under alternative D. Some with a biocentric perspective may view the application of a science-based adoptive management plan as beneficial over the long term.

Some people would not even have to experience these impacts firsthand to be beneficially affected. Without ever visiting the North Cascades Complex, these individuals would be beneficially impacted simply by knowing that the naturalness of the North Cascades Complex was being protected and restored. The magnitude of impact is unknown.

Cumulative

The flooding in October 2003 destroyed most of the upper portion of the Stehekin Valley Road. For the foreseeable future, access to various portions of the Stehekin Valley may take much longer and may exclude some visitors from accessing portions of the area. Most mountain lake visitors are used to hiking long distances, often off trail, to access lakes, so the cumulative impact to mountain lake visitors from reduced access would likely be negligible over the short and long terms.

Compared to alternative A, there would be long-term major beneficial cumulative impacts on those who believe that continued stocking in wilderness and continued presence of reproducing populations of fish would compromise natural processes. There would be long-term major adverse cumulative impacts on anglers who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles to remove fish from wilderness areas, cumulative impacts either would be beneficial or adverse over the long term.

Fishery management actions, especially fish removal, would impose an administrative presence in wilderness, in addition to established administrative actions such as research and monitoring, ranger patrols, and fire management actions. Taken together, these additional fishery management actions would have a minor adverse cumulative impact on opportunities for solitude over the long term. Due to the cessation of stocking, long-term moderate to major beneficial cumulative impacts on wilderness values would be expected.

The displacement of anglers to other wilderness areas would result in negligible adverse impacts, even if all anglers decided to fish elsewhere.

Conclusion

Sport-fishing opportunities would be vastly reduced compared to alternative A because all stocking in the North Cascades Complex would cease, and fish would be removed from all lakes. This would result in long-term moderate to major beneficial impacts on opportunities for solitude in areas where fishing opportunities would be eliminated. However, fishing opportunities would continue to exist in the nine deep lakes where complete fish removal may not be feasible, resulting in long-term minor adverse impacts on opportunities for solitude.

Impacts on solitude from fish removal activities would be minor to moderate and adverse over the long term.

Anglers who choose to fish elsewhere because of reduced fishing opportunities would experience long-term minor adverse impacts. Anglers who believe the fishing experience cannot be duplicated elsewhere would experience long-term major adverse impacts.

The cessation of anglers using wilderness would result in long-term beneficial impacts on other visitors.

Those with an anthropocentric perspective (valuing human use and enjoyment of wilderness) would experience long-term major adverse impacts under alternative D. Some of those with an anthropocentric perspective would view the application of a science-based adaptive management plan to remove fish as a negligible impact, and some would view this as beneficial.

Those with strong biocentric views (support protection of natural processes in wilderness areas) of wilderness would experience long-term major beneficial impacts because all fish would be removed (where feasible) under alternative D. Some with a biocentric perspective would view the application of a science-based adaptive management plan as beneficial over the long term. Impacts on those wilderness users who would not be aware that nonnative fish have been removed from the lakes would be negligible over the long term.

Cumulative impacts on fishing opportunities in mountain lakes from reduced access would likely be negligible over the short and long terms. There would be long-term major beneficial cumulative impacts on those who believe that the continued stocking in wilderness and continued presence of reproducing populations of fish would compromise natural processes. There would be long-term major adverse cumulative impacts on anglers who believe that human use and enjoyment of wilderness should continue. Depending on one's views regarding the application of science-based adaptive management principles to remove fish from wilderness areas, cumulative impacts either would be beneficial or adverse over the long term. Fishery management actions, including fish removal, would have long-term minor adverse cumulative impacts on solitude. Due to the cessation of stocking, long-term moderate to major beneficial cumulative impacts on wilderness values would be expected.

The displacement of anglers to other wilderness areas would result in long-term negligible adverse cumulative impacts, even if all anglers decided to fish elsewhere.

HUMAN HEALTH

Human health issues potentially affected by the proposed alternatives include potential exposure to antimycin through consumption of chemically treated stocked fish and potential exposure to methyl-mercury and persistent organic pollutants through consumption of contaminated fish. Impacts would occur from stocking or fish removal activities under the proposed management actions (refer to tables 4 and 5 in the “Alternatives” chapter).

This section describes the methods used to analyze impacts on human health and results of the analysis. The following section discusses the regulations and policies used to guide NPS decision-making, in addition to the assumptions and thresholds used to analyze impacts on human health.

GUIDING REGULATIONS AND POLICIES

Servicewide NPS regulations and policies emphasize protection of human health in all park operations and visitor activities. *NPS Management Policies* state that the NPS will seek to provide a safe and healthful environment for visitors and employees, and that NPS will reduce or remove known hazards and apply other appropriate measures, including closings, guarding, signing, or other forms of education to do this (NPS 2001a, 8.2.5).

The U.S. Environmental Protection Agency (EPA) has guidance that provides benchmarks for concentrations of organic contaminants in fish to avoid elevated cancer risk in consumers (EPA 2004). These include recommended benchmarks for levels of methyl-mercury and other persistent organic pollutants in fish for protection of human health.

METHODOLOGY AND ASSUMPTIONS

The following discussion describes the methodology used to evaluate the impacts on human health that could result from implementation of any of the proposed alternatives. Analysis methods are qualitative and are based on reviews of existing data and literature and best professional judgment. The analysis presented in this section assumes that the historic and current stocking of trout in high mountain lakes has created favorable conditions for human take and consumption of stocked fish.

Impact Threshold Definitions

The following thresholds were used to determine the magnitude of impacts on human health as a result of implementation of any of the alternatives, including stocking and treatment methods:

Negligible: The impact on human health would not be measurable or perceptible.

Minor: The impact on human health would be measurable or perceptible, but it would be limited in effect.

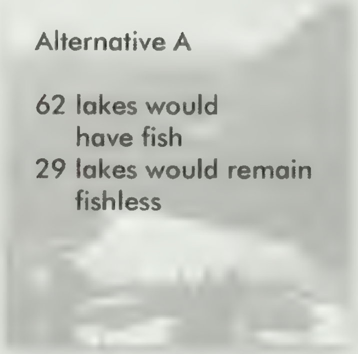
Moderate: The impact on human health would be sufficient to cause noticeable effects to human health.

Major: The impact on human health would be substantial, resulting in substantial, noticeable effects to human health.

IMPACTS OF THE ALTERNATIVES ON HUMAN HEALTH

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A (no action) would continue existing management of the 91 lakes in the study area. The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.



Alternative A

62 lakes would have fish

29 lakes would remain fishless

Impacts of Current Fish Stocking on Human Health

The majority of impacts on human health under alternative A would be related to the age of the fish, number of fish stocked, and/or density of reproducing fish in the lakes (refer to table 6 in the "Alternatives" chapter). In the 62 lakes under alternative A that have been stocked with fish, direct adverse impacts on human health from consuming fish exposed to persistent organic pollutants or methyl-mercury would be negligible. Twenty-eight different organochlorine compounds were analyzed for lakes sampled in the North Cascades Complex, and only two were observed—total PCBs (polychlorinated biphenyl) and DDE (dichlorodiphenyldichloroethylene)—at concentrations below Food and Drug Administration Action Levels for fish tissue of 2 and 5 milligrams per kilogram (mg/kg), respectively. (FDA Action Levels refer to the sale and distribution of goods in the market place.) Average PCB concentrations in sampled lakes exceeded EPA's guideline screening value of 0.02 mg/kg for elevated cancer risk. The researchers caution that these fish tissue results are preliminary, and additional sampling is needed. Also, the EPA guidelines screening values are based on conservative assumptions (for example, consumption of two 8-ounce meals of fish per month every year over a 70-year lifetime). A high level of protection is built into the thresholds—lakes containing fish would continue to be monitored for persistent organic pollutants and methyl-mercury in fish tissue, and any human health concerns would be communicated to the public.

Impacts of Current Lake Treatment Methods on Human Health

None of the 91 lakes addressed in this plan/EIS are currently treated nor would they be treated under alternative A; therefore, no impacts on human health would occur from consumption of fish exposed to piscicides.

Cumulative Impacts

Cumulative impacts on human health are considered for past, present, and future projects occurring in the North Cascades Complex or outside its boundary. No new major roads, trails, resorts, or major upgrades of facilities are proposed or are in the planning stages. Some trails were flooded, so access has been eliminated or reduced. Visitor use is expected to remain at about the same levels that it has been at for several years, resulting in similar levels of use at most lakes and connected streams.

Mountain lake fisheries on National Forest System lands that surround the North Cascades Complex are managed by the WDFW. The department's management approach, described in WDFW (2001), is expected to be similar in the foreseeable future to current management activities. There is concern about persistent organic pollutants and methyl-mercury found in these lakes, but lakes stocked in the past are assumed to have a range of impacts on human health pollutant concentrations similar to those analyzed for North Cascades Complex lakes, which means negligible to minor impacts under alternative A.

Overall, the impacts associated with other projects and fishery management actions in the area, plus impacts from potential airborne pollution, added to the impacts predicted under alternative A, would result in negligible impacts on human health over the long term.

Conclusion

Alternative A would have negligible impacts on human health over the long term from the consumption of stocked fish that may have been exposed to persistent organic pollutants and methyl-mercury, and no adverse impacts on human health from any lake treatment chemicals since none would be used. Cumulative impacts on human health would be negligible adverse over the long term.

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

The emphasis of this alternative would be to provide sport-fishing opportunities in approximately 29 of the 91 study area lakes, and approximately 49 lakes either would remain in their current fishless state or be returned to a fishless condition. Another 13 lakes would be evaluated prior to determining final management actions. Restocking of nonreproducing fish in the 13 lakes would only be allowed if monitoring results indicate fish are not causing major adverse impacts.

The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

Impacts of Proposed Fish Stocking on Human Health

Under alternative B, impacts related to the consumption of fish potentially contaminated with methyl-mercury and persistent organic pollutants would be similar to alternative A. Reducing high densities of fish and removing fish in an additional 19 lakes using chemical treatment would decrease the probability of consumption and result in negligible impacts on human health.

Impacts of Proposed Lake Treatment Methods on Human Health

The treatment methods proposed for each lake were selected based on the type of fish population present (reproducing versus nonreproducing) and physical characteristics of the lake, such as depth and surface area (refer to appendix E for details about the 91 lakes). The chemical method involves application of the piscicide, antimycin, to 19 lakes under alternative B (refer to table 7 in the "Alternatives" chapter). The chemical method would be used in large lakes with reproducing fish populations where mechanical removal methods would not be practical. As described in the "Alternatives" chapter, the concentration of antimycin necessary to remove fish is considered to be harmless to humans (Rosenlund 2002). Antimycin breaks down very quickly in a fish's body and in the water, reducing the likelihood of contamination if fish were caught and consumed (Rosenlund 2002). Also, antimycin is used in such small quantities that residues are extremely small, and it has not been shown to bioaccumulate (Schnick 1974). In addition, the NPS would implement mitigation measures to keep visitors and anglers away from treated lakes and to educate anglers about the use of antimycin and its effects on fish (see appendix I). Because of the lack of evidence of human health effects and the mitigation that would be used, impacts of fish removal using antimycin would be negligible to minor and adverse over the long term. Lakes containing fish would continue to be monitored for persistent organic pollutants and methyl-mercury in fish tissue, and any human health concerns would be communicated to the public.

To ensure treated fish are not caught and consumed following chemical treatment, lakes would be temporarily closed to visitors, if necessary, during and immediately after chemical treatments until it is determined that the chemical has dissipated. Educational materials about treatment dates and locations would be posted on bulletin boards, on the North Cascades Complex website, and at visitor centers. Park rangers would alert visitors as to which lakes were being treated (or were recently treated) when backcountry overnight use permits are issued. In addition, educational materials would be provided to visitors explaining the closures and describing how to recognize fish treated with antimycin (the fish becomes discolored and lethargic).

Cumulative Impacts

Cumulative impacts on human health under alternative B would be very similar to those described for alternative A, with the addition of negligible impacts on human health from the unlikely potential for consumption of chemically treated fish. Overall, the impacts associated with other projects and fishery management actions in the area, plus possible impacts from potential airborne pollution, added to the impacts predicted under alternative B, would result in negligible to minor adverse cumulative impacts on human health.

Conclusion

Alternative B would have negligible to minor adverse impacts on human health over the long term from stocking decisions and consumption of stocked fish that may have been exposed to persistent organic pollutants and methyl-mercury. Proposed chemical treatments that would be used to remove fish from 19 lakes would have negligible adverse impacts on human health over the long term. Cumulative impacts on human health would be negligible to minor adverse over the long term.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

Alternative C applies a new adaptive management framework to the 91 lakes in the study area, wherein 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish and 2 lakes would be evaluated for restocking. Of the other 11 lakes in the national recreation areas, 3 would remain fishless, 3 would have high density reproducing fish removed, and stocking would be discontinued in 5 lakes. The remaining 69 lakes (which are in the national park) would be returned to their natural fishless condition or would remain fishless.

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter and appendix E.

Impacts of Proposed Fish Stocking on Human Health

The types of impacts of fish stocking on human health would be similar to those described for alternative A; however, under alternative C, there would be approximately 80 lakes that would be fishless, as opposed to 29 lakes under alternative A, with reductions in fish densities in other lakes. Loss of fish resources in these lakes would result in decreased potential of human consumption of fish contaminated with methyl-mercury and persistent organic pollutants. Impacts on human health would be negligible over the long term.

Impacts of Proposed Lake Treatment Methods on Human Health

Under alternative C, the types of impacts associated with the various lake treatments methods would be the same as described for alternative B; however, the numbers of lakes affected by those treatments would increase, with slightly more potential for human consumption of chemically treated fish. Under alternative C, 25 lakes would be treated with the piscicide, antimycin, an increase of 6 lakes over alternative B. Impacts on human health would be negligible over the long term.

Cumulative Impacts

Overall, the impacts associated with other projects and fishery management actions in the area, plus potential impacts from increased airborne pollution, added to the impacts predicted under alternative C, would be expected to result in negligible to minor cumulative adverse impacts on human health over the long term.

Conclusion

Alternative C would have negligible to minor adverse impacts on human health over the long term from stocking decisions and consumption of stocked fish that may have been exposed to persistent organic pollutants and methyl-mercury. Proposed chemical treatments that would be used to remove fish from 25 lakes would have negligible adverse impacts on human health over the long term. Cumulative impacts on human health would be negligible to minor adverse over the long term.

ALTERNATIVE D: 91 LAKES WOULD BE FISHLESS

The emphasis of this alternative is that 91 lakes in the study area would eventually be fishless. The "Alternatives" chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the "Alternatives" chapter and appendix E.

Alternative D

91 lakes would be fishless

Impacts of Proposed Fish Stocking on Human Health

Under alternative D, the 29 lakes that are currently fishless would remain fishless, and fish stocking would be gradually phased out. The lakes that currently have fish would be treated to remove fish over time, with the exception of the 9 lakes identified in table 7 where complete fish removal may not be feasible. Loss of fish resources in lakes would result in negligible impacts on human health over the long term.

Impacts of Proposed Lake Treatment Methods on Human Health

Under alternative D, the types of impacts associated with the various lake treatment methods would be the same as described for alternative B; however, the number of study area lakes affected by those treatments would increase, with more potential impacts on human health from possible consumption of chemically treated fish. The chemical method involving application of the piscicide, antimycin, would be used in 25 lakes under alternative D, the same as alternative C, but an increase of 7 lakes over the number that would be chemically treated under alternative B. Impacts on human health would be negligible over the long term.

Cumulative Impacts

Overall, the impacts associated with other projects and fishery management actions in the area, plus impacts from potential airborne pollution, added to the impacts predicted under alternative D, would be expected to result in negligible to minor adverse cumulative impacts on human health over the long term.

Conclusion

Alternative D would have negligible to minor adverse impacts on human health over the long term from consumption of fish from previously stocked lakes that may have been exposed to persistent organic pollutants and methyl-mercury. Proposed chemical treatments used to remove fish from 25 lakes would have negligible adverse impacts on human health over the long term. Cumulative impacts on human health would be negligible to minor adverse over the long term.

SOCIOECONOMIC RESOURCES

GUIDING REGULATIONS AND POLICIES

The *National Environmental Policy Act of 1969* requires that economic and social impacts be analyzed in an environmental impact statement when they are interrelated with natural or physical impacts. Economic and social impacts would potentially result from the natural and physical effects of changes to fish populations in North Cascades Complex mountain lakes; therefore, this plan/EIS addresses economic and social impacts.

METHODOLOGY AND ASSUMPTIONS

Visitors who fish in the mountain lakes of the North Cascades Complex spend money in nearby communities as part of the recreational experience. Limiting or discontinuing the stocking program may affect the level of this spending and affect people who depend on it. The methodology for assessing the relative economic contribution of sport fishing in the study area was derived by estimating the annual angler numbers and applying an estimate of annual expenditures provided by the WDFW. Then, in order to estimate other secondary economic contributions from these annual expenditures to the job market and income, the model IMPLAN was used (see the "Socioeconomic Resources" section of the "Affected Environment" chapter). The impact analysis involves qualitatively assigning a change (increase or decrease) in anglers to each alternative, based on the activities under that alternative that would increase or decrease fish population. Then, the resulting economic effect is both qualitatively and quantitatively estimated. When spending in the regional or local economy is affected, a negligible, minor, moderate, or major impact would occur. The criteria for meeting these thresholds are explained below.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

The regional study area for the purpose of the socioeconomic impact analysis includes the North Cascades Complex and Whatcom, Skagit, and Chelan counties in Washington State. The local study area includes the small towns near the North Cascades Complex that have businesses that provide supplies and equipment to anglers visiting the North Cascades Complex. See the "Socioeconomic Resources" section in the "Affected Environment" chapter for further details.

IMPACT THRESHOLD DEFINITIONS

Negligible: No measurable effect on the socioeconomic environment.

Minor: Only a small sector of the local and regional economies would be affected and would not be readily apparent.

Moderate: A relatively small sector of the socioeconomic environment, or the relationship between sectors of the local and regional economies, would be measurably affected, but would not alter basic socioeconomic functions and structure.

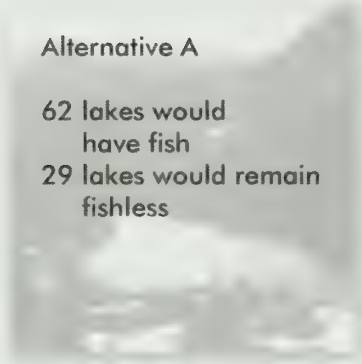
Major: Changes to the local and regional economies would occur and would become readily apparent in the form of shifts in socioeconomic functions and structure. In certain cases, entirely new economic sectors would be created, or established sectors eliminated.

IMPACTS OF THE ALTERNATIVES ON SOCIOECONOMIC RESOURCES

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Impacts on the Regional Economy

The current mountain lakes fishery management activities at the North Cascades Complex, which are described in the "Alternatives" chapter, would continue under the no-action alternative. The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.



Alternative A

62 lakes would have fish
29 lakes would remain fishless

The estimated number of visitors to the North Cascades Complex who engage in sport fishing in the study area lakes is estimated at 1,000 anglers per season (refer to the "Fishing" section under "Visitor Use and Experience" in the "Affected Environment" chapter). The WDFW estimates that approximately $49.79 per trip is expended by those who sport fish in the state (WDFW 1996).

Using this estimate of expenditures, and the angler use of the study area, the total annual expenditures of anglers to the area are approximately $50,000, with additional secondary (indirect) expenditures and labor income. When factoring in the relationship between output, jobs, and income for sport fishing associated with the North Cascades Complex mountain lakes fishery in the three-county area (Whatcom, Skagit and Chelan counties), direct economic output ($50,000 annually) would most likely support one to two associated direct jobs and $10,000 in direct labor income on an annual basis (IMPLAN, Copyright Minnesota IMPLAN Group, Inc.).

The total (direct plus secondary) spending attributable to recreational mountain lake fishing in the North Cascades Complex represents, at most, 0.001% of total retail sales in the three-county area, and 0.006% of total retail sales in the combined unincorporated areas of the three counties (WDOR 2003). Revenues from mountain lakes fishing, then, account for roughly $1 out of every $100,000 spent in the three-county region. In comparison to the three-county economy as a whole, assuming angler use under this alternative remains steady (approximately

10.5% of total backcountry permit visitation) over the next 15 years, these expenditures would have a beneficial, yet negligible, long-term impact on the regional economy.

Impacts on the Local Economy

Local businesses would also continue to be affected over the long term (see the "Socioeconomic Resources" section in the "Affected Environment" for local businesses in the vicinity of the study area). Proprietors of local businesses on the west side of the North Cascades Complex that cater to fishing indicate that fishing of mountain lakes in the North Cascades Complex is very limited and accounts for a negligible portion of revenues (NPS, Roy Zipp, pers. comm., 2004). A variety of factors appear to contribute to the limited use, including access difficulties, perception that fishing is prohibited, and a general lack of knowledge that many mountain lakes in the North Cascades Complex contain fish. Given the assumption that average visitation and angling use would remain constant over the next 15 years, local businesses on the west side would continue to experience beneficial, yet negligible, long-term impacts.

Impacts on businesses in Stehekin, including the Stehekin Valley Ranch in Lake Chelan National Recreation Area, would also continue to be affected if current management of the fishery continued over the next 15 years. The relative greater use by anglers of the mountain lakes in the Lake Chelan National Recreation Area indicates the popularity of that area. Although no formal measurement of local expenditures by anglers who stay or pass through Stehekin is available, it is assumed that seasonal expenditures are higher than other local communities. For example, an estimated 28 guests per day visit the Stehekin Valley Ranch from June through August. Pack trips to Rainbow and surrounding lakes, and day trips to Coon Lake, would continue to be a large part of this local business. Existing and projected angler use in this area assumes that most anglers stay overnight and obtain backcountry overnight permits for an extended trip to the lakes around the Stehekin area. Under alternative A, expenditures of anglers who visit the ranch and other businesses in the area as part of their trip would continue, but are not expected to increase substantially. This assumption is made because the overall park visitation has remained steady over the past 10 years (see the "Visitor Use" section and table 22 in the "Affected Environment"' chapter).

The proprietor of the Stehekin Valley Ranch has indicated that sport fishing is a large part of its income. Continuing the fishery management program under this alternative would have a long-term beneficial impact on this local business.

The 1995 *Lake Chelan General Management Plan* offers yet a different perspective of the reasons people visit the Stehekin area. Using data from 1992, the *Lake Chelan General Management Plan* identifies sightseeing, hiking, wildlife observation, photography, and bicycling as the primary visitor use activities for people visiting Stehekin. The 10%–12% of visitors who do visit the area and engage in sport fishing is a relatively small proportion of the annual visitation to the area (NPS 1995). Alternative A would have long-term beneficial impacts on local businesses in Stehekin.

Cumulative Impacts

Cumulative impacts are the direct and indirect impacts of alternative A in combination with other impacts that are occurring to the socioeconomic environment. The economy in communities surrounding the North Cascades Complex continues to evolve as industry diversification occurs. The historic basis for many northwestern Washington communities is natural resource-based industries, such as agriculture, fishing, and timber. A downturn in timber has forced diversification in all three counties (Whatcom, Skagit, and Chelan) into manufacturing industries, as well as into the recreation and tourism industries. The total (direct plus secondary) spending attributable to recreational high lakes fishing in the North Cascades Complex represents, at most, 0.001% of total retail sales in the three-county area, and 0.006% of total retail sales in the combined unincorporated areas of the three counties (WDOR 2003). In comparison to the three-county economy as a whole, these expenditures would continue to have negligible cumulative impacts on the local and regional economies.

Conclusion

Alternative A would have long-term negligible impacts on the local and regional economies. Estimated revenues from mountain lake angling account for roughly $1 out of every $100,000 spent in the three-county region. The effects of continuation of the current fishery management program on some local businesses in the Stehekin area would be beneficial since some patrons may also engage in sport fishing in the mountain lakes located in Lake Chelan National Recreation Area. Expenditures associated with sport fishing in the mountain lakes in the North Cascades Complex would continue to have long-term negligible cumulative impacts on the local and regional economies.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

Impacts on the Regional Economy

The emphasis of this alternative is to eliminate or reduce the density of reproducing fish from certain mountain lakes in the study area under alternative B. The "Alternatives" chapter provides a detailed description of alternative B. For more information on the 91 lakes, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

Assuming that the 13 lakes to be evaluated would all be available for fishing at some point in the future, a total of 42 lakes (compared to 62 lakes under alternative A) would be available for fishing. While this decrease in available lakes for angler use is apparent, the relative socioeconomic impact of angler expenditures would have a negligible adverse impact on the regional economy. A relatively small amount (roughly $1 out of every $100,000) of direct and indirect economic contributions to the three-county area result from the sport fishing expenditures of those who use the high mountain lakes in the North Cascades Complex.

Impacts on the Local Economy

Alternative B, overall, would have a negligible impact on local businesses since the relative contribution of angler expenditures compared to total visitor expenditures is small. One business, such as the Stehekin Valley Ranch in the Lake Chelan National Recreation Area, notes that sport fishing in the high mountain lakes is very important to their livelihood. Under alternative B, six lakes in Lakes Chelan National Recreation Area would become fishless over time, and some would be treated to remove fish then re-evaluated for stocking at some point in the future. The Lake Chelan National Recreation Area backcountry use is one of the high-use areas in the North Cascades Complex. While it is estimated that 10.5% of backcountry users engage in sport fishing overall, should this use decrease, it would have long-term, major, and adverse impacts on some local businesses. This is a qualitative assessment, given that some businesses may rely on other visitor expenditures other than that of anglers. Other businesses may choose to transition their services to offer fishing in the Stehekin River as an alternative to fishing in the study area lakes.

Day hiking to Coon Lake from Stehekin would remain a popular activity, and sport fishing would continue at the lake under alternative B. Proprietors who provide services to day hikers and angling supplies for those visiting Coon Lake would not be economically affected by this alternative.

Cumulative Impacts

Cumulative impacts would be similar to alternative A. While the number of lakes available for fishing would decrease under alternative B, the overall contribution of sport fishing to the local and regional economies would be long term and negligible. The 1995 Lake Chelan *General Management Plan* did not project any substantive changes in visitor use through the year 2007; therefore, cumulative impacts on most local businesses in Stehekin would be long term and negligible. Some local businesses in Stehekin who report a large dependence on sport fishing as a source of revenues, such as the Stehekin Valley Ranch, would experience a long-term, major, and adverse impact from this alternative, since other visitor uses are not expected to substantially increase (NPS 1995).

Conclusion

Although there would be a decrease in lakes available for fishing, the relative socioeconomic impact of angler expenditures would have a negligible, adverse impact on the local and regional economies. A relatively small amount (roughly $1 out of every $100,000) of direct and indirect economic contributions to the three-county area is from sport-fishing expenditures of anglers who fish at the high mountain lakes in the North Cascades Complex. Some local businesses in Stehekin that depend on sport fishing as a primary source of income would experience a long-term major adverse impact under alternative B. Cumulative impacts would be similar to alternative A. While the number of lakes available for fishing would decrease under alternative B, the overall contribution of sport fishing to the local and regional economies would be long term and negligible.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

Impacts on the Regional Economy

Alternative C applies a new adaptive management framework to the 91 lakes in the study area, wherein 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish and 2 lakes would be evaluated for restocking. Of the other 11 lakes in the national recreation areas, 3 would remain fishless, 3 would have high density reproducing fish removed, and stocking would be discontinued in 5 lakes. The remaining 69 lakes (which are in the national park) would be returned to their natural fishless condition or would remain fishless.

The "Alternatives" chapter provides a detailed description of alternative C. For more information on the 91 lakes, refer to tables 5 and 12 in the "Alternatives" chapter and appendix E.

The relative socioeconomic impact of angler expenditures would have a negligible adverse impact on the regional economy. A relatively small amount (roughly $1 out of every $100,000) of direct and indirect economic contributions to the three-county area is from the sport-fishing expenditures of anglers who fish the high mountain lakes in the North Cascades Complex. While alternative C would preclude sport fishing in the majority of the study area lakes, the effect of this decreased activity would not be measurable within the three-county area; hence, the impact would be long term, negligible, and adverse.

Impacts on the Local Economy

The relative socioeconomic impact of angler expenditures under this alternative would be negligible on the local economy over the long term. This is because on the west side of the North Cascades Complex, fishing expenditures are currently not substantial, and therefore, the effects of this alternative would not be measurable (see the "Socioeconomic Resources" section in the "Affected Environment" chapter). In the Stehekin area, the effects of alternative C would be the same as alternative B; that is, long-term negligible and adverse impacts would occur because the lakes in the Lake Chelan National Recreation Area would be managed the same under both alternatives.

The town of Newhalem is on State Route 20 in Ross Lake National Recreation Area.

Compared to alternative A, the effects of alternative C on the Stehekin area from angler expenditures would have a negligible impact on the local economy. Angler visitation to the Stehekin area overall constitutes an estimated average visitation of 10% to 12% (see the "Socioeconomic Resources" section in the "Affected Environment" chapter). This average is not expected to substantially change over the next 10 years; therefore, the relative economic contributions of sport fishing in the Stehekin area would remain a small portion of total revenues. However, some local businesses in Stehekin who depend on sport fishing as a primary source of income would experience a long-term, major, and adverse impact from reduced fishing opportunities proposed in alternative C.

Cumulative Impacts

Cumulative impacts of alternative C would be long term, negligible, and adverse overall to the local and regional economies. In general, angling opportunities would decrease under alternative C, which may force anglers to fish in other areas outside the North Cascades Complex. However, since the relative contribution of sport fishing to the local and regional economies is small, any shifts in angler use would be expected to result in negligible economic impacts. The majority of visitors to the North Cascades Complex are from the state of Washington, so any displacement of those visitors who also engage in sport fishing would most likely result in an increase in other areas in the state. This increase and associated expenditures (less than $50,000 direct expenditures per year) in other areas outside the North Cascades Complex would not be measurable. Cumulative impacts overall would be long term, negligible, and adverse.

Cumulative impacts on the Stehekin area overall would be long term, negligible, and adverse. The proportion of visitors who engage in sport fishing compared to other uses is relatively small (10%–20%) in the Stehekin area. Some lakes in the study area would remain available for fishing in Lake Chelan National Recreation Area, and while there would be a decreased fishing opportunity compared to alternative A, the impacts on the local economy overall would not be measurable.

Sport-fishing opportunities would decrease in the national park portion of the North Cascades Complex, which would contribute to an increase in the number of anglers who may choose to fish in the national recreation areas. This increase in angler visitation would have a negligible, but long-term beneficial impact on the Stehekin area. Some local businesses in Stehekin, however, may experience a long-term, major, and adverse impact from reduced fishing opportunities compared to alternative A because the number of lakes available for fishing in the Lake Chelan National Recreation Area would be reduced.

Conclusion

The number of lakes available for fishing would decrease under alternative C, and the relative socioeconomic impact of angler expenditures would have a negligible adverse impact on the local and regional economies. Revenues from mountain lakes angling in the North Cascades Complex account for roughly $1 out of every $100,000 spent in the three-county region. Some local businesses in Stehekin that depend on sport fishing as a primary source of income would experience a long-term, major adverse impact from alternative C. Cumulative impacts on the local and regional economies overall would be long term and negligible, while some businesses in Stehekin may experience long-term, major adverse impacts because other visitor uses are not expected to increase substantially. There would be beneficial economic impacts on Stehekin area businesses if anglers chose to fish in the Lake Chelan National Recreation Area since fishing in the mountain lakes outside of the national recreation areas would be eliminated.

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

Alternative D

91 lakes would be fishless

Impacts on the Regional Economy

The goal of this alternative is that the 91 lakes in the study area would eventually be fishless. Sport-fishing opportunities in most of these lakes would generally be eliminated within a period of 5 years, and self-sustaining (reproducing) populations of fish would be gradually removed over time. The rate of removal would depend on unpredictable changes in resource (funding and personnel) availability and differences among fish removal methods. Complete removal of self-sustaining populations of fish in some of the larger, deeper lakes might not be feasible (9 lakes potentially fall into this category—refer to table 7). These lakes would continue to provide sport-fishing opportunities for the foreseeable future, and the goal of complete removal might never be achieved. The “Alternatives” chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the “Alternatives” chapter and appendix E.

This alternative would result in lost income, both direct and indirect, to the regional economy. Overall, while the relative contribution to the regional economy from sport fishing in the 91 lakes is small compared to alternative A, the impact of these lost expenditures would be long term, minor, and adverse.

Impacts on the Local Economy

Removal of all fishing opportunities in the study area lakes would have a long-term, minor, adverse impact on the local economy compared to alternative A. While the relative contribution of angler expenditures to local businesses is small, compared to alternative A, the loss of sport fishing in the high mountain lakes in the study area would be measurable but minor. Loss of all fishing opportunities in the mountain lakes in the Lake Chelan National Recreation Area would have a minor adverse impact on local businesses in Stehekin, since the revenues of sport fishing are relatively small compared to other revenue sources; however, some businesses that depend on sport fishing in the study area lakes in the Lake Chelan National Recreation Area would experience a long-term, major, and adverse impact.

Cumulative Impacts

The negligible but adverse direct and indirect long-term socioeconomic impact of alternative D, in combination with the long-term growth and diversification the region has experienced recently, would result in a long-term, negligible, and adverse cumulative impact. Cumulative impacts on the local economy, overall, would also be long term, negligible, and adverse because the relative contribution of sport fishing expenditures related to the mountain lakes in the study area is small. Some businesses in Stehekin may experience long-term, major adverse impacts from loss of this revenue source.

Conclusion

Overall, the local and regional economies would experience long-term negligible to minor adverse impacts from the elimination of sport fishing in the mountain lakes in the study area. Compared to alternative A, some Stehekin businesses would experience long-term major adverse impacts under alternative D if their primary source of income is from anglers who fish in the study area lakes. Cumulative impacts, overall, would be long term, negligible, and adverse.

MANAGEMENT AND OPERATIONS

GUIDING REGULATIONS AND POLICIES

Direction for the North Cascades Complex management and operations is set forth in the park's enabling legislation, *General Management Plan* (NPS 1988b), and *Strategic Plan* (NPS 2000a). Specifically related to the proposed mountain lakes fishery management plan, the *General Management Plan* includes the following management objectives:

> Provide the minimum NPS development necessary to provide essential services to visitors and to facilitate environmentally sound and resource-oriented recreational use.
>
> Cooperate with other governmental agencies, private organizations, local residents, and members of the public in (1) ensuring that land uses within and adjacent to the designated parklands are compatible, to the greatest degree possible, with preservation of the resource values; (2) providing adequate information to visitors on the recreational, interpretive, and educational opportunities as well as the visitor services available in the North Cascades; (3) developing programs for managing vegetation, wildlife, and fisheries; and (4) developing plans and programs for dealing with all other problems of mutual concern.

The *Strategic Plan* also contains strategies and long-term goals that describe management and operational objectives through September 30, 2005.

METHODOLOGY AND ASSUMPTIONS

A long-term commitment of funding and personnel would be needed to manage the mountain lakes fishery. Table 30 in the "Affected Environment" chapter provides the annual base funding the park has received over the past 12 years. All of the alternatives were analyzed assuming the current trend shown in table 30 of minimal increase in the park's annual budget would continue over the next 15 years. Though innovative partnerships and non-NPS funding may be available as a means of limiting NPS costs, impacts on park operations were analyzed with the assumption that NPS funding and personnel would be required to carry out the majority of management actions, especially monitoring and fish removal.

To accomplish monitoring and fish removal, a field crew of biological technicians composed of a team leader (term position) and three assistants (seasonal positions) would be hired provided soft funding could be obtained. These personnel would primarily be responsible for field work during the summer months. Existing staff at the park would supervise these employees and provide overall project management as part of existing park operations.

For management alternatives that include stocking (alternatives A, B, and C), it was assumed that the WDFW and their stakeholders would continue to stock lakes with no direct cost to the NPS.

Personnel costs were developed with the assumption that both permanent and seasonal NPS staff would be required to manage the mountain lakes fishery. Funding for resource management staff in the North Cascades Complex covers salaries and provides for a small amount of discretionary monies for ongoing, high-priority resource management projects. To fully implement each of the adaptive management alternatives presented in this plan/EIS, additional funding and personnel would be needed. Various sources of "soft" funding are available through the NPS but only on a competitive basis and typically for a maximum of three years.

Helicopters are often needed as the minimum tool to transport heavy sampling gear and time-sensitive samples to and from remote lakes. This photo shows NPS and USGS-Water Resources Division biologists sampling fish in Wilcox/Lillie, Upper Lake to detect persistent organic pollutants and methyl-mercury in fish tissue.

Costs of fish removal using gillnets were calculated using data from ongoing fish removal efforts in Sequoia-Kings Canyon National Park, California. That program developed a successful, intensive gillnetting approach on small lakes (less than 5 acres) that currently costs approximately $15,000 per 1 acre of lake surface area (NPS, D. Boiano, pers. comm., 2003). Differences between Sequoia-Kings and North Cascade Complex lakes in terms of lake morphometry (shape and structure of lakes) and other logistical constraints could make the overall cost of gillnetting higher in the North Cascades Complex, but the uncertain costs of these confounding factors were not calculated into the analyses.

The current cost of antimycin ($450/unit) was used to help develop treatment costs. Antimycin application costs were derived in part from antimycin treatment methods conducted on lakes in Rocky Mountain National Park. The calculations for estimating antimycin treatment costs are heavily dependent on an accurate understanding of lake volumes and residence times of water in the lakes. Because some estimates must use simplified assumptions of lake volumes and residence times, actual costs of lake treatments with antimycin could vary considerably from the estimates provided in the analysis.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS

The geographic area evaluated for impacts on North Cascades Complex management and operations includes the north and south units of the North Cascades National Park, the Ross Lake National Recreation Area, and the Lake Chelan National Recreation Area.

IMPACT THRESHOLD DEFINITIONS

Negligible. An action would have a no measurable impact on operations in the North Cascades Complex.

Minor. Actions with minor impacts would affect operations in the North Cascades Complex in a way that would be difficult to measure. The impacts on the resources management budget and workload would be short term, with little material effect on other ongoing resources management programs.

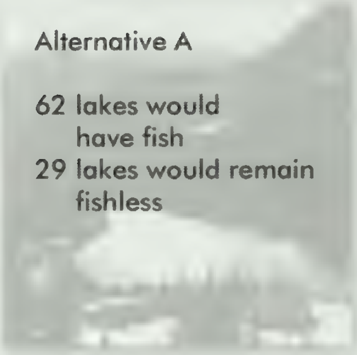
Moderate. Actions with moderate impacts would measurably affect operations in the North Cascades Complex. Resources management staff workloads and priorities would need to be rearranged to implement mountain lakes fishery management actions, and as a result, ongoing science and/or stewardship programs would be reduced in scope or potentially eliminated.

Major. Management actions would affect resource management operations in the North Cascades Complex. Funding for management actions would exceed the current resource management budget by 10%, consume all discretionary funding, and require additional personnel over and above what would normally be expected to be funded.

IMPACTS OF THE MANAGEMENT ALTERNATIVES ON NORTH CASCADES COMPLEX MANAGEMENT AND OPERATIONS

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

The current mountain lakes fishery management activities at the North Cascades Complex would continue under the no-action alternative. The "Alternatives" chapter provides a detailed description of alternative A. For more information on the 91 lakes, refer to table 5 and figure 4 in the "Alternatives" chapter and appendix E.



Alternative A

62 lakes would have fish
29 lakes would remain fishless

The costs of continuing to manage mountain lakes under alternative A would be primarily associated with stocking, very limited monitoring, and project oversight. These actions would cost approximately $18,000 per year and primarily be borne by the WDFW. Over a 15-year period, not accounting for other factors such as inflation, estimated costs to implement alternative A would be $270,000. The North Cascades Complex would continue to receive, on an irregular basis, NPS funds for periodic monitoring and research projects and funds from constituency groups to support park programs. These supplemental funds would probably be minimal. Given that the annual base funding for the North Cascades Complex (refer to table 30 in the "Affected Environment" chapter) is not expected to substantially increase, the expenditure of funds to support alternative A would be negligible in the long term.

Impacts of Current Fish Stocking on North Cascades Complex Management and Operations

Alternative A would require little NPS oversight because the cost of management actions would continue to be largely borne by the WDFW and their stakeholders. No additional NPS staff or funding would be needed because no intensive monitoring or fish removal projects would be undertaken; therefore, the impacts of alternative A would be negligible and long term.

Impacts of Current Fish Removal on North Cascades Complex Management and Operations

Fish removal is not part of current management, so there would be no cost or impact.

Cumulative Impacts

North Cascades Complex budgets, overall, are continuing to be stretched by increased public visitation, resource protection needs, and growing needs to improve infrastructure. The most recent flooding during the fall of 2004 is an example of an unexpected natural event that has cumulative impacts on North Cascades Complex management and operations. These types of events, as well as other demands on park operations, would continue. Cumulative impacts on operations and management would be negligible to minor and adverse over the long term.

Conclusion

Alternative A would have a negligible to minor adverse impact on management and operations over the long term. Total implementation costs would be $270,000 over a 15-year period and would primarily be borne by the WDFW. Average annual costs would be approximately $18,000 per year.

Cumulative impacts would be negligible to minor and adverse over the long term.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

The emphasis of this alternative would be to eliminate or reduce self-sustaining fish populations from naturally formed mountain lakes in the North Cascades Complex. Some lakes would be restocked with nonreproducing fish at low densities once reproducing fish have been removed. Fish stocking would be allowed only where biological integrity could be conserved. Lakes where critical information is missing would not be stocked until that information becomes available. It is assumed that future stocking would continue to be funded and implemented by the WDFW and their stake holders with no additional cost to the NPS over the long term. An extensive monitoring program (see appendix F) would be implemented in order to enable adaptive management and ensure conservation of biological integrity over the long term.

Alternative B

29 lakes would have fish
49 lakes would be fishless
13 lakes would be evaluated for restocking

The "Alternatives" chapter provides a more detailed description of alternative B. For more information on the 91 lakes under consideration in this plan, refer to tables 5 and 10 in the "Alternatives" chapter and appendix E.

Fish removal with gillnets would involve initial start-up costs for durable equipment and materials, including gillnets and electrofishing gear (see table 34). Most of the costs of gillnetting would involve personnel time because gillnetting is a very labor-intensive process. Removing fish with antimycin would be less labor intensive than gillnetting. Labor costs would be limited to antimycin application and pre- and post-treatment monitoring of native biota. The cost of antimycin would be one of the most expensive components, particularly for larger lakes because relatively large volumes of antimycin would be needed for lake treatment. Fish in lakes less than 5 acres would be removed with a combination of intensive gillnetting, trapping, and electrofishing of inlet and outlet streams. Lakes larger than 5 acres would be chemically treated with the piscicide antimycin. The acreage criterion for selecting fish removal methods could change if other less costly/labor-intensive methods become available, or if other factors such as lake depth and amounts of woody debris render gillnetting infeasible.

TABLE 34: ESTIMATED TOTAL COSTS OF THE FISHERY MANAGEMENT PROGRAM UNDER ALTERNATIVE B

This table shows detailed costs for the first three years of fish removal using gillnets and antimycin. Estimated costs for antimycin assume treatment at 8 parts per billion, plus possible re-treatment, if needed. Equipment needs are based on fish removal work performed in other national parks.

Item	Description	Year I	Year 2	Year 3
Personnel	GS-7/9 Crew Leader, term appointment subject furlough (8-months/year)	$22,400	$23,300	$24,400
	3-GS-5 Biological Technicians (4 month seasonal appointments)	$25,300	$26,400	$27,500
	Technical assistance with pre-treatment monitoring and antimycin application		$11,000	
Supplies and Equipment	Gillnets: 15 per lake (60 nets, $300 each) plus two extra in years 2 and 3	$18,000	$1,000	$1,000
	Antimycin ($450/unit; up to 56 units for Middle Blum and 22 units for Lower Blum.	0	$35,100	0
	Three float tubes and five neoprene chest waders	$900	0	0
	Two LR-24 Electrofishers (battery powered, 24-volt backpack mounted)	$9,100	0	0
	Electrofisher accessories (2 each)	$2,900	0	0
	(6-foot, one-piece anode pole and ring, rat-tail cathode, 24 volt 7Ah sealed battery, BC-24PS battery-charger, 10KV electrical safety gloves [4])			
	Two Knaack boxes for storing gear on site	$1,000	0	0
	Backpacks, sleeping bags, tents, camping gear, and field supplies	$6,000	$1,000	$1,000
Services	Zooplankton and macroinvertebrate sample analyses	$12,000	$13,000	$14,000
Travel and Transport	Helicopter ($600/hour, minimum 2-hour flights per lake to ferry equipment and personnel; two extra flights needed in year 2 to treat Blum Lake)	$9,600	$12,000	$9,600
	Per diem	$1,200	$2,000	$1,300
Training	Aviation training, pesticide applicator training	$2,000	$4,000	$2,000
Public Outreach and Education	Develop interpretive media (exhibit, web page, brochure) and work with news media	$6,900	$4,500	$4,900
Total Annual Costs:		$117,300	$133,300	$85,700
Average Annual Program Cost:				**$112,100**
	Total costs for first three years of program implementation			**$336,300**

Fish in lakes with very limited spawning habitat (such as Wilcox/Lillie, Upper Lake) would also be removed by breaking the cycle of reproduction indirectly through spawning habitat exclusion. This method, however, has only been selected for one lake at this point due to uncertainty of success.

The estimated costs of using gillnets and antimycin for fish removal under alternative B are provided in table 35. Seven lakes have been identified for the first round of fish removal using these various methods (highlighted in gray in table 35). It is assumed that it would take three years to remove fish from these six lakes, and success in fish removal efforts would be monitored and evaluated before the next round of lakes would be chosen for fish removal. Based on results, the methods and associated costs could vary from those indicated in table 35 as personnel gain experience, and innovative fish removal methods potentially become available.

Table 34 shows that the estimated annual costs of alternative B for the first three years of program implementation would be approximately $336,300. As experience is gained in lake treatment methods, larger lakes would undergo fish removal. Costs would increase because removal methods would become more difficult and time-consuming to implement, and larger volumes of antimycin would be needed for those lakes selected for chemical treatment. Therefore, the estimated annual costs after the first three years would increase to approximately $150,000. Without funding, the impact on park operations would be minimal because no additional fishery management actions would be performed.

Given the number of lakes to be treated, monitored, evaluated, and restocked in alternative B, a conservative estimate of total costs over the next 15 years would be approximately $2.14 million (NPS, R. Zipp, pers. comm., 2004). This total cost estimate assumes that all lakes could be treated within 15 years. This assumption may be too ambitious given the uncertainty of funding to implement the fishery management plan and the low feasibility of removing fish from larger, deeper lakes.

As noted previously under “Methodology and Assumptions,” if the funding for the North Cascades Complex remains at current levels, fishery management actions could not be paid for with base funding because it is specifically earmarked for base operations. Base funding levels have remained static in recent years (refer to table 30 in the “Affected Environment” chapter), while costs have risen due to inflation, cost of living increases, and other factors. This trend underscores the point that there are few discretionary dollars available to fund additional resource management programs such as a fishery management plan. Assuming this static trend continues, then reliance upon soft funding from the sources noted previously would be essential for plan implementation.

The impact of alternative B on management and operations would depend on the amount of soft funding received to implement the fishery management plan. Reliance on soft funding sources would mean that fishery management actions would be implemented in a piecemeal fashion and be subject to the unpredictable availability of funding for the foreseeable future. At a minimum, NPS resource management personnel would routinely have to write funding proposals and secure soft funding and develop and maintain partnerships to ensure that steady

TABLE 35: ESTIMATED COSTS OF FISH REMOVAL FOR MANAGEMENT ACTIONS UNDER ALTERNATIVE B

Note: The lakes highlighted in gray have been identified for the first round of fish removal.

Lake Name	NPS Lake Code	Depth (feet)	Area (acres)	Initial Fish Removal Method Proposed for Alternative B	Estimated Fish Removal Cost[a]
Battalion	MLY-02-01	16	6.3	Piscicide	$94,500
Bear	MC-12-01	152	25.7	Piscicide	$70,010
Berdeen	M-08-01	215	126.7	Piscicide	$416,521
Berdeen, Lower	M-07-01	36	7.5	Piscicide	$13,310
Berdeen, Upper	M-09-01	Unknown[b]	9.5	Piscicide	$16,354
Blum (Lower/West, No. 4)	LS-07-01	26	6.4	Piscicide	$11,771
Blum (Largest/Middle, No. 3)	M-11-01	33	12.9	Piscicide	$15,622
Bouck, Lower	DD-04-01	63	10.8	Piscicide	$19,404
Dagger	MR-04-01	16	8.2	Piscicide	$11,248
Dee Dee, Upper	MR-15-01	89	12.2	Gillnet	$25,460
Diobsud No. 1	LS-01-01	11	1	Gillnet	$15,000
Diobsud No. 2, Lower	LS-02-01	17	3.1	Gillnet	$46,500
Doubtful	CP-01-01	68	30.2	Piscicide	$42,496
Doug's Tarn	M-21-01	10	5	Gillnet	$75,000
Green	M-04-01	153	80	Piscicide	$193,764
Hanging	MC-08-01	33	88.8	Piscicide	$55,516
Hozomeen	HM-02-01	67	97.5	Piscicide	$109,008
Kettling	MR-05-01	23	9.9	Piscicide	$12,681
McAlester	MR-10-01	23	13.2	Piscicide	$13,808
Monogram	M-23-01	122	29.1	Piscicide	$64,720
Rainbow	MR-14-01	108	15.5	Piscicide	$34,159
Skymo	PM-03-01	20	10.8	Piscicide	$12,508
Sourdough	PM-12-01	107	27.6	Piscicide	$55,855
Triplet, Lower	SM-02-01	7	2.2	Gillnet	$33,000
Triplet, Upper	SM-02-02	12	2.4	Gillnet	$36,000
Wilcox/Lillie, Upper	EP-06-01	65	10.5	Spawning habitat exclusion	Volunteer labor
Wilcox/Sandie, Lower	EP-05-01	20	5.4	Gillnet	$10,904
				Total estimated cost of fish removal	**$1,505,119**

Notes:

a. This table provides a conservative estimate of fish removal costs for alternative B based upon the following assumptions: $15,000/acre for gillnetting (NPS, D. Boiano, pers. comm., 2003). Assume one-time use of piscicide antimycin per lake, $450/unit of Fintrol® (trade name) at 4 parts per billion, at $45 /acre-foot. Lake volume calculations assume lake basin is cone shaped (formula = 0.33 × maximum depth x area). Treatment costs also include salary for four-person field crew ($3,000 for 2 weeks at small lake; $4,500 for 3 weeks at medium lake; $6,000 for 4 weeks at large lake) and helicopter transportation of equipment (2 flights small lake, 4 flights medium lake, 6 flights large lake). Small lakes 1–5 acres; medium lakes, 6–20 acres; large lakes 20+ acres.

b. The depth of this lake is unknown, but for treatment purposes, a depth of 50 feet was assumed in order to calculate the cost of antimycin.

sources of funding and in-kind assistance remained available to implement the fishery management plan. Once funding were secured, resource management staff would have to take on the additional burden of training personnel, assisting with field work, and providing overall project oversight. Interpretive staff would need to assist with public outreach and education to foster public understanding and awareness of the program. Under this likely scenario, the impacts on North Cascades Complex management and operations would be moderate, adverse, and long term because NPS personnel would have to shift workload priorities to accommodate these additional tasks, and other ongoing resource management actions may not be accomplished.

Should NPS base funding levels increase and be made available to fund implementation of the fishery management plan, the adverse impacts onpark management and operations would decline to a minor level because (a) resources management staff would not have the additional burden of routinely seeking soft funding to implement this plan, and (b) additional resource management personnel could be available to manage the additional workload. Depending on the amount of funding available, the fishery management plan would also be implemented in a more holistic fashion, with objectives such as removal of self-sustaining fish populations being achieved in shorter timeframes.

Cumulative Impacts

Various unanticipated issues can greatly influence North Cascades Complex operations and the funds required to respond to these events. For example, extensive flooding in 2004, national security issues, or wildfire can cumulatively affect available funds and the way the funds are appropriated. In addition, management priorities may need to be shifted to address pressing issues and to accommodate reduced funding. The cumulative impact of these unanticipated issues would be adverse and long term, but the magnitude of adverse impacts cannot be determined because the future is uncertain.

Conclusion

Alternative B would have moderate adverse impacts on management and operations over the long term, assuming all sources of funding remain fairly constant. Total implementation costs would be approximately $2.14 million over the next 15 years. Average annual costs for implementation are projected at approximately $112,100 for the first three years. As experience is gained conducting lake treatment and management, the number of lakes treated increases, raising costs to nearly $150,000 per year. Future stocking would be funded and implemented by the WDFW. However, should a long-term increase in NPS base funding for fishery management become available, implementing alternative B would have negligible to minor adverse impacts over the long term. Other sources of funding would be sought to reduce impacts on the North Cascades Complex operating budget.

Cumulative adverse impacts on operations could arise from the need to respond to future unanticipated events such as flooding, wildfire, or other events. However, the magnitude of adverse impacts may range from negligible to major depending on the severity of individual future events, which could reduce the amount of potential funding available to implement the fishery management plan or cause the NPS to shift priorities to respond to more pressing needs.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 LAKES MAY HAVE FISH)

Alternative C

9 lakes would have fish
80 lakes would be fishless
2 lakes would be evaluated for restocking

Alternative C applies a new adaptive management framework to the 91 lakes in the study area, wherein 9 lakes in Ross Lake and Lake Chelan National Recreation Areas would have fish and 2 lakes would be evaluated for restocking. Of the other 11 lakes in the national recreation areas, 3 would remain fishless, 3 would have high density reproducing fish removed, and stocking would be discontinued in 5 lakes. The remaining 69 lakes (which are in the national park) would be returned to their natural fishless condition or would remain fishless.

Impacts of Proposed Fishery Management on North Cascades Complex Management and Operations

Alternative C would place a greater emphasis on fish removal in the national park lakes. Costs associated with removing fish in alternative C are shown in table 36. These estimates indicate that compared to alternative B, an additional $700,000 more funding would be needed to remove reproducing fish populations.

Management actions that would have an impact on North Cascades Complex management and operations would include stocking, fish removal, monitoring, evaluation, public outreach, and education. It is assumed that future stocking would continue to be funded and implemented by the WDFW and their stakeholders with no additional cost to the NPS over the long term.

Fish removal with gillnets would involve initial start-up costs for durable equipment and materials, including gillnets and electrofishing gear (see table 34). Most of the costs of gillnetting would involve personnel time because gillnetting is a very labor-intensive process. Removing fish with antimycin would be much less labor intensive than gillnetting. The cost of piscicide would be the most expensive component, particularly for larger lakes. Labor costs would be limited to piscicide application and pre- and post-monitoring of native biota.

As with alternative B, the estimated costs for the first three years of program implementation are $336,300 (see table 34), or approximately $112,100 annually. Success in fish removal efforts on these initial lakes would be monitored and evaluated before the next round of lakes would be chosen for fish removal. Based on results, the methods and associated costs would vary from those indicated in tables 34 and 36. As experience is gained in lake treatment methods, effort (and costs) to remove reproducing fish from mountain lakes would increase to approximately $150,000 annually. Costs would increase because removal methods would become more difficult and time-consuming to implement, and larger volumes of antimycin would be needed for those lakes selected for chemical treatment. Given the number of lakes to be treated, evaluated, and restocked in alternative C, total costs over the next 15 years would be approximately $700,000 more than alternative B, or approximately $2.84 million over 15 years (NPS, R. Zipp, pers. comm., 2004).

TABLE 36: ESTIMATED COSTS OF FISH REMOVAL FOR MANAGEMENT ACTIONS UNDER ALTERNATIVE C

Note: The lakes highlighted in gray have been identified for the first round of fish removal.

Lake Name	NPS Lake Code	Depth (feet)	Area (acres)	Initial Fish Removal Method Proposed for Alternative C	Estimated Fish Removal Cost[a]
Battalion	MLY-02-01	16	6.3	Piscicide	$94,500
Bear	MC-12-01	152	25.7	Piscicide	$70,010
Berdeen	M-08-01	215	126.7	Piscicide	$416,521
Berdeen, Lower	M-07-01	36	7.5	Piscicide	$13,310
Berdeen, Upper	M-09-01	Unknown[b]	9.5	Piscicide	$16,354
Blum (Largest/Middle, No. 3)	M-11-01	33	12.9	Piscicide	$15,622
Blum (Lower/West, No. 4)	LS-07-01	26	6.4	Piscicide	$11,771
Bouck, Lower	DD-04-01	63	10.8	Piscicide	$19,404
Dagger	MR-04-01	16	8.2	Piscicide	$11,248
Dee Dee, Upper	MR-15-01	89	12.2	Gillnet	$25,460
Diobsud No. 1	LS-01-01	11	1	Gillnet	$15,000
Diobsud No. 2, Lower	LS-02-01	17	3.1	Gillnet	$46,500
Doubtful	CP-01-01	68	30.2	Piscicide	$42,496
Doug's Tarn	M-21-01	10	5	Gillnet	$75,000
Firn	MP-02-01	38	5.7	Piscicide	$8,617
Green	M-04-01	153	80	Piscicide	$193,764
Hanging	MC-08-01	33	88.8	Piscicide	$55,516
Hidden	SB-01-01	258	61.7	Piscicide	$248,391
Hozomeen	HM-02-01	67	97.5	Piscicide	$109,008
Ipsoot	LS-06-01	51	8.9	Piscicide	$16,040
Jeanita	DD-01-01	8	1.4	Gillnet	$15,000
Kettling	MR-05-01	23	9.9	Piscicide	$12,681
McAlester	MR-10-01	23	13.2	Piscicide	$13,808
Monogram	M-23-01	122	29.1	Piscicide	$64,720
Rainbow	MR-14-01	108	15.5	Piscicide	$34,159
Skymo	PM-03-01	20	10.8	Piscicide	$12,508
Sourdough	PM-12-01	107	27.6	Piscicide	$55,855
Stout	EP-09-02	176	25.2	Piscicide	$77,863
Stout, Lower	EP-09-01	8	1	Gillnet	$15,000
Thornton, Lower	M-20-01	108	55.1	Piscicide	$100,209
Trapper	GM-01-01	161	147.2	Piscicide	$363,933
Triplet, Lower	SM-02-01	7	2.2	Gillnet	$33,000
Triplet, Upper	SM-02-02	12	2.4	Gillnet	$36,000
Wilcox/Lillie, Upper	EP-06-01	65	10.5	Spawning habitat exclusion	Volunteer labor
Wilcox/Sandie, Lower	EP-05-01	20	5.4	Gillnet	$10,904
				Total cost of fish removal	**$2,350,172**

Notes:

a. This table provides a conservative estimate of fish removal costs for alternative B based upon the following assumptions: $15,000/acre for gillnetting (NPS, D. Boiano, pers. comm., 2003). Assume one-time use of piscicide antimycin per lake, $450/unit of Fintrol® (trade name) at 4 parts per billion, at $45 /acre-foot. Lake volume calculations assume lake basin is cone shaped (formula = 0.33 × maximum depth x area). Treatment costs also include salary for four-person field crew ($3,000 for 2 weeks at small lake; $4,500 for 3 weeks at medium lake; $6,000 for 4 weeks at large lake) and helicopter transportation of equipment (2 flights small lake, 4 flights medium lake, 6 flights large lake). Small lakes 1–5 acres; medium lakes, 6–20 acres; large lakes 20+ acres.

b. The depth of this lake is unknown, but for treatment purposes, a depth of 50 feet was assumed in order to calculate the cost of antimycin.

As noted in "Methodology and Assumptions," if the base funding for North Cascades Complex remains at current levels, then fishery management actions could not be paid for with base funding because it is specifically earmarked for base operations. Base funding levels have remained static in recent years while costs have increased due to inflation, cost of living increases, and other factors. This trend underscores the point that there are few discretionary dollars available to fund additional resource management programs such as this fishery management plan. Assuming this static trend continues, reliance on soft funding from the sources noted previously would be essential for plan implementation.

The impact of alternative C on park management and operations would be similar to the impact of alternative B, with impacts essentially dependent on the amount of soft funding received to implement the fishery management plan. Reliance on soft funding sources would mean that fishery management actions would be implemented in a piecemeal fashion and subject to the unpredictable availability of funding for the foreseeable future. At a minimum, resource management personnel would routinely have to write funding proposals and secure soft funding and develop and maintain partnerships to ensure that steady sources of funding and in-kind assistance remained available to implement the fishery management plan. Once funding were secured, resource management personnel would need to take on the additional burden of training personnel, assisting with field work, and providing overall project oversight. Interpretive staff would need to assist with public outreach and education to foster public understanding and awareness of the program. Under this scenario, the impacts on park management and operations would be moderate, adverse, and long term because NPS personnel would have to shift workload priorities to accommodate these additional tasks, and other ongoing resource management actions may not be accomplished.

Cumulative

Various unanticipated events can greatly influence park management and operations and the funds required to respond to these events. For example, extensive flooding in 2004, national security issues, or wildfire can cumulatively affect available funds and the way the funds are appropriated. In addition, management priorities may need to be shifted to address pressing issues and to accommodate reduced funding. The cumulative impact of these unanticipated issues would be adverse and long term, but the magnitude of adverse impact, however, cannot be determined because the future is uncertain.

Conclusion

Alternative C would have similar moderate adverse impacts on management and operations as alternative B over the long term. Total implementation costs would be approximately $2.84 million over the next 15 years. Average annual costs would be similar to alternative B, but the additional lakes targeted for fish removal would increase the total cost. Future stocking would be funded and implemented by WDFW. Similar to alternative B, if a long-term increase in NPS base funding becomes available, adverse impacts would become minor. Other sources of funding would be sought to reduce impacts on the North Cascades Complex operating budget.

Cumulative adverse impacts on operations could arise from the need to respond to future unanticipated events such as flooding, wildfire, or other events. However, the magnitude of adverse impact may range from negligible to major depending on the severity of individual future events, which could reduce the amount of potential funding available to implement the fishery management plan or cause the NPS to shift priorities to respond to more pressing needs.

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

Under alternative D, none of the 91 lakes would be available for fishing, with the possible exception of the 9 lakes identified in table 7 where complete fish removal may not be feasible. The "Alternatives" chapter provides a detailed description of alternative D. For more information on the 91 lakes, refer to tables 5 and 13 in the "Alternatives" chapter and appendix E.

Alternative D

91 lakes would
be fishless

Impacts of Proposed Fishery Management on North Cascades Complex Management and Operations

Alternative D would be very similar in costs to alternative C because the majority of costs would be associated with fish-removal treatments at the study area lakes (NPS, R. Zipp, pers. comm., 2004). Costs could actually be slightly less than alternative C because fishery management actions would be centered exclusively on fish removal. There would be no costs associated with stocking, but there would be costs associated with monitoring the recovery of native organisms in lakes. The cost saving would be difficult to quantify at this point in time given the uncertainty of projecting cost savings across a 15-year timeframe. These cost savings, however, could be offset by increased law enforcement personnel to prevent unsanctioned stocking of lakes.

Another element that could have a substantial impact on management and operation costs is the valuable in-kind role of volunteer contributions to fishery management, such as assistance with lake monitoring and fish removal. Given the goal of removing all fish from the study area lakes, it is unlikely that WDFW or its angling stakeholders would be willing to assist because they would no longer have a stake in the outcome. This means that the NPS would bear the sole burden of fish removal and lose potentially valuable partnerships and in-kind sources of funding and assistance. In light of these various factors, a conservative cost estimate for implementing alternative D would be approximately $3 million over the next 15 years.

Although costs would be higher under alternative D compared to alternatives B and C, the impact of alternative D on park management and operations would be similar to the impacts of alternatives B and C. Impacts would essentially depend on the amount of soft funding received to implement the fishery management plan. Reliance upon soft funding sources would mean that fishery removal actions would be implemented in a piecemeal fashion and subject to the unpredictable availability of funding for the foreseeable future. At a minimum, resource management personnel would routinely have to write funding proposals and secure soft funding. Once funding were secured, resource management personnel would need to take on the additional burden of training personnel, assisting with field work, and providing overall project oversight. Interpretive staff would have to assist with public outreach and education to foster public understanding and awareness of the program. Under this likely scenario, the impacts on park management and operations would be moderate, adverse, and long term because NPS staff would have to shift workload priorities to accommodate additional tasks, and other ongoing resource management actions may not be accomplished.

Cumulative Impacts

As with alternatives B and C, various unanticipated events can greatly influence park operations and the funds required to respond to these events. For example, extensive flooding in 2004, national security issues, or wildfire can cumulatively affect available funds and the way the funds are appropriated. In addition, management priorities may need to be shifted to address pressing issues and to accommodate reduced funding. The cumulative impact of these unanticipated events would be adverse and long term, but the magnitude of adverse impact, however, cannot be determined because the future is uncertain.

Conclusion

Alternative D would have moderate adverse impacts on management and operations over the long term, assuming all funding sources remain fairly constant. Total cost of implementing alternative D would be approximately $3 million over the next 15 years. Average annual costs for fish removal would be similar to alternative C. Although there are no average annual costs associated with fish stocking, the additional costs of protection required to prevent unsanctioned stocking of lakes would increase total implementation costs. Other sources of funding would be sought to reduce impacts on the North Cascades Complex operating budget.

Cumulative adverse impacts on operations could arise from the need to respond to future unanticipated events such as flooding, wildfire or other events. However, the magnitude of adverse impact may range from negligible to major depending on the severity of individual future events, which could reduce the amount of potential funding available to implement the fishery management plan or cause the NPS to shift priorities to respond to more pressing needs.

SUSTAINABILITY AND LONG-TERM MANAGEMENT

In accordance with the *National Environmental Policy Act* (NEPA), and as further explained in NPS *Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision-making*, consideration of long-term impacts and the effects of foreclosing future options should pervade any NEPA document. According to *Director's Order 12*, and as defined by the World Commission on Environment and Development, "sustainable development is that which meets the needs of the present without compromising the ability of future generations to meet their needs." For each alternative considered in a NEPA document, considerations of sustainability must demonstrate the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity. This relationship is described below for each alternative.

The NPS must consider if the effects of the project alternatives involve tradeoffs of the long-term productivity and sustainability of park resources for the immediate short-term use of those resources. It must also consider if the effects of the alternatives are sustainable over the long term without causing adverse environmental effects for future generations (NEPA section 102(c)(iv)).

Alternative A (No Action): Existing Management Framework of 91 Lakes (62 Lakes Have Fish)

Alternative A would trade off the short-term use of park resources for long-term productivity. Fishing opportunities would continue in the short and long term; however, reproducing nonnative fish would remain in some lakes, compromising the long- term productivity of native species. In addition, fish would remain in naturally fishless lakes over the long term.

Alternative B: Proposed Adaptive Management of 91 Lakes under a New Framework (42 Lakes May Have Fish) (Preferred Alternative)

Alternative B would apply adaptive management principles to remove reproducing populations of nonnative fish where feasible. Following removal, some lakes would be restocked with nonreproducing fish. This action would provide some short- and long-term angling opportunities for this and future generations. Compared to alternative A, alternative B would help conserve biological integrity over the long term because it proposes the removal of fish from mountain lakes and either restocking them with nonreproducing fish or allowing select lakes to go fishless. As indicated in the impact analyses, with the application of scientifically based adaptive management principles, the long-term adverse impacts of alternative B on resources in the North Cascades Complex

would range from negligible to moderate. There would be no impairment of park resources and values, as defined by *NPS Management Policies* (NPS 2001a). However, in order to be sustainable, continued stocking would require long-term management, including monitoring and adaptive management to conserve biological integrity. These actions would require periodic commitment of funds and personnel for the foreseeable future to ensure protection of park resources.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 NATIONAL RECREATION AREA LAKES MAY HAVE FISH)

Alternative C would also apply adaptive management principles. Alternative C is different from alternatives A and B because it would require removal of fish from all naturally fishless mountain lakes in the national park—these lakes would not be restocked. Except for some lakes where removal may not be feasible, this alternative would deny future generations the ability to fish in mountain lakes in the national park portion of the North Cascades Complex. In the national recreation areas, self-sustaining (reproducing) fish populations would be removed, some select lakes would be restocked, and others would remain fishless. Over the short and long term, these actions would reduce angling opportunities compared to alternatives A and B. As indicated in the impact analyses, with the application of scientifically based adaptive management principles, the long-term adverse impacts of alternative C on resources in the national recreation areas would range from negligible to moderate. There would be no impairment of park resources and values, as defined by *NPS Management Policies* (NPS 2001a). However, in order to be sustainable, continued stocking would require long-term management, including monitoring and adaptive management to conserve biological integrity. These actions would require periodic commitment of funds and personnel for the foreseeable future to ensure protection of park resources.

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

Alternative D proposes the removal of all fish populations, where feasible, in all study area lakes in the national park and national recreation areas, and no lakes in the study area would be restocked. Compared to alternative A, this would allow the conservation of biological integrity in the greatest number of lakes over the long term. Fish would be removed using intensive gillnetting in combination with electrofishing, cobbling over of spawning habitat, and application of the piscicide, antimycin. As indicated in the impact analyses, the long-term impacts of fish removal methods would range from negligible to moderate with no impairment of park resources, as defined by *NPS Management Polices* (NPS 2001a). Until fish were removed, these actions would require monitoring, adjustment of management actions, and commitment of funds and personnel over the long term to ensure protection of resources in the North Cascades Complex. There may be a greater potential for illegal stocking under this alternative, which may have short- and long-term impacts on park resources.

No lakes would be stocked or restocked (following fish removal) under alternative D. From a management standpoint, alternative D would be most sustainable because it would eventually eliminate any long-term management actions needed to maintain the mountain lakes fishery compared to alternatives A, B, and C. However, fishing opportunities in mountain lakes for this and future generations would largely be eliminated in the North Cascades Complex, except for a few lakes where complete removal of self-sustaining fish populations may not be feasible. Anglers would have to fish in lakes outside the North Cascade Complex to experience fishing in mountain lakes.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

The NPS must consider if the effects of the alternatives cannot be changed or are permanent (that is, the impacts are irreversible). The NPS must also consider if the impacts on park resources would mean that once gone, the resource could not be replaced; in other words, the resource could not be restored, replaced, or otherwise retrieved (NEPA section 102(c)(v)).

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A would continue to have long-term impacts on park resources, and some may be permanent. There would be a permanent presence of nonnative fish in naturally fishless mountain lakes. The greatest concern is that reproducing populations of nonnative fish would remain in lakes and, in turn, continue to have permanent, adverse impacts on native biota. Self-sustaining (reproducing) fish populations could completely eliminate some species of native aquatic organisms. Once permanently gone from lakes, some of these aquatic species may not be restored or replaced; therefore, alternative A has the greatest potential to result in irreversible or irretrievable commitments of resources.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

Compared to alternative A, alternative B would reduce the potential for irreversible or irretrievable commitments of resources by applying a scientifically based adaptive management program to conserve biological integrity while maintaining the mountain lakes fishery. Self-sustaining fish populations would be removed where feasible. Some lakes would be restocked with nonreproducing fish, and others would remain fishless. In lakes where self-sustaining populations would be eliminated, the fish would be irretrievably lost. In an estimated 9 lakes where complete removal of reproducing populations of fish may not be feasible (refer to table 7), there may be irreversible or irretrievable impacts to certain sensitive species of native aquatic organisms. At the landscape scale, however, populations of these organisms may remain viable in other lakes or habitat where fish are not present. Lakes that would remain available for sport fishing would be stocked with nonreproducing fish. If monitoring results indicated that biological integrity could no longer be conserved, impacts could be stopped, and potentially reversed, simply by ending stocking.

ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 NATIONAL RECREATION AREA LAKES MAY HAVE FISH)

Compared to alternatives A and B, alternative C would further reduce the potential for irreversible or irretrievable commitments of natural resources. While alternative C would apply adaptive management practices to lakes in the national recreational areas, the lakes in the national park would be returned to a fishless condition by removing all fish populations. Removal of fish populations would be irreversible and irretrievable. Nine lakes in the national park (refer to table 7) may still contain self-sustaining fish populations over the long term because complete removal may not be feasible in those lakes. The irreversible and irretrievable commitments of resources in these lakes would be similar to alternative B with respect to native aquatic organisms. However, compared to alternative B, all study area lakes in the national park portion of the North Cascades Complex would remain or become fishless. Sport-fishing opportunities would be lost as long as the fishery management plan remained viable and the lakes remained fishless.

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

Alternative D would present the least potential for irreversible and irretrievable commitments of resources. Nine lakes would still remain in question as to the feasibility of complete removal of fish populations; therefore, the potentially irreversible ecological impacts of fish in these lakes would be the same as alternatives B and C. There would be a permanent, irretrievable loss of fish populations, and loss of these populations in conjunction with ceasing to stock would eliminate sport-fishing opportunities in the mountain lakes as long as the fishery management plan remained viable and the lakes remained fishless.

ADVERSE IMPACTS THAT COULD NOT BE AVOIDED

The NPS is required to consider if the alternative actions would result in impacts that could not be fully mitigated or avoided (NEPA section 101(c)(ii)).

ALTERNATIVE A (NO ACTION): EXISTING MANAGEMENT FRAMEWORK OF 91 LAKES (62 LAKES HAVE FISH)

Alternative A would continue to have adverse impacts that could not be mitigated or avoided. The greatest concern would be those lakes where self-sustaining (reproducing) fish populations remained in naturally fishless lakes in the study area.

ALTERNATIVE B: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (42 LAKES MAY HAVE FISH) (PREFERRED ALTERNATIVE)

Alternative B would also be of concern for the estimated nine lakes where complete fish removal may not be feasible (refer to table 7). In addition, the use of fish removal methods (including gillnetting, electrofishing, and piscicides) may have adverse impacts that could not be avoided using available mitigation measures. Although fish removal using the piscicide, antimycin, would be closely monitored and mitigated, there may be short-term adverse impacts on some native aquatic species. The temporary use of mechanized equipment, such as helicopters, and presence of crews would have unavoidable short-term impacts on some park visitors. Even with mitigation (such as alerting visitors that lake management actions involving equipment may take place), some visitors may be adversely affected.

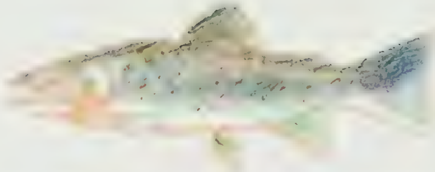
ALTERNATIVE C: PROPOSED ADAPTIVE MANAGEMENT OF 91 LAKES UNDER A NEW FRAMEWORK (11 NATIONAL RECREATION AREA LAKES MAY HAVE FISH)

Alternative C would have unavoidable adverse impacts similar to those described for alternative B. Nine lakes may still have reproducing populations of fish because complete fish removal may not be feasible. Equipment and activities would disrupt some visitors, and fish removal methods may have unavoidable short-term adverse impacts on some native biota.

ALTERNATIVE D:
91 LAKES WOULD BE FISHLESS

Alternative D would have unavoidable adverse impacts similar to those described for alternatives B and C. Nine lakes may still have reproducing fish populations because complete fish removal may not be feasible. Equipment and activities would disrupt some visitors, and fish removal methods may have unavoidable short-term adverse impacts some native biota. For those who believe that fishing in the mountain lakes in North Cascades Complex provides an experience that cannot be duplicated elsewhere, elimination of the mountain lakes fishery would have an unavoidable impact on their recreation experience.

Canada
Mt. Baker Wilderness
Mt. Shuksan
North C
Nationa
(north
Baker Lake
Skagit River
Marblemount
Sauk River
Suiattle River
Darrington
Boulder River Wilderness
0
5
10
20



Consultation and Coordination

Welcome

You are now in the "Consultation and Coordination" chapter. Here are the topics you can read about.

HISTORY OF PUBLIC INVOLVEMENT 457

THE SCOPING PROCESS 457

AGENCY CONSULTATION 459

LIST OF PREPARERS AND CONSULTANTS 463

LIST OF RECIPIENTS 465

TECHNICAL ADVISORY COMMITTEE CHARTER MOUNTAIN LAKES FISHERY MANAGEMENT PLAN AND ENVIRONMENTAL IMPACT STATEMENT 468

HISTORY OF PUBLIC INVOLVEMENT

The public involvement activities for this *Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS) fulfill the requirements of the *National Environmental Policy Act* (NEPA) and National Park Service (NPS) *Director's Order 12* (NPS 2001b).

THE SCOPING PROCESS

The National Park Service divides the scoping process into two parts: internal scoping and external (public) scoping. Internal scoping for this plan/EIS involved discussions among NPS personnel regarding issues, management alternatives, mitigation measures, the analysis boundary, appropriate level of documentation, lead and cooperating agency roles, available references and guidance, defining the purpose and need for management actions, and other related dialogue.

Public scoping is the early involvement of the interested and affected public in the environmental analysis process. The public scoping process helps ensure that people have been given an opportunity to comment and contribute early in the decision-making process. For this plan/EIS, project information was distributed to individuals, agencies, and organizations early in the scoping process, and people were given opportunities to express concerns or views and identify important issues or even other alternatives.

Taken together, internal and public scoping are essential elements of the NEPA planning process. The following sections describe the various ways the NPS conducted internal and public scoping for this plan/EIS.

INTERNAL SCOPING

This process began on July 16, 2002, at North Cascades Complex Headquarters in Sedro-Woolley, Washington. During the two-day meeting, the NPS identified the purpose of and need for action, management objectives, issues, and impact topics. It was determined that a Technical Advisory Committee should be established to ensure an interdisciplinary, science-based approach to management. Various roles and responsibilities for developing the fishery management plan were also clarified, including the need for the Washington Department of Fish and Wildlife (WDFW) to be a cooperating agency. The results of the meetings were captured in an internal scoping report, now on file as part of the administrative record.

On October 1, 2002, the NPS and WDFW met to discuss the proposed plan/EIS. The discussions included an overview of the NEPA process, a clarification of the purpose of the environmental impact statement and its relationship to a mountain lakes fishery management plan, and the composition and function of the Technical Advisory Committee. During the meeting, information gaps and data management needs were identified, and it was agreed that public scoping and the environmental impact analysis process should be initiated.

Following the first NPS/WDFW coordination meeting, a Technical Advisory Committee of subject matter experts was chartered to advise and provide technical recommendations to the NPS on matters regarding scientific data and analysis. The committee met periodically to review and supplement necessary background information and data needed for this plan/EIS. The committee also recommended impact analysis techniques and various management options and provided technical review of draft documents related to this plan/EIS process. The first of eight Technical Advisory Committee meetings for this plan/EIS was held on November 14, 2002.

Members of the Technical Advisory Committee

National Park Service, Environmental Quality Division

National Park Service, North Cascades Complex

Washington Department of Fish and Wildlife

PUBLIC SCOPING

Public scoping formally began on January 16, 2003, with the *Federal Register* publication of the notice of intent (NOI) to prepare an environmental impact statement (Federal Register Vol. 68 (11), pp. 2355–2356). The notice of intent summarized the history of fishery management in the North Cascades Complex, discussed preliminary issues and management actions, listed the project website (www.nps.gov/NOCA/highlakes.htm), and announced the public scoping meetings. A number of federal, state, local, and tribal entities were directly contacted, as well as organizations expressing an interest in the plan/EIS.

In March 2003, the NPS and WDFW held four public scoping meetings to discuss issues and management alternatives for this plan/EIS.

The Washington State locations for the four public scoping meetings were

Sedro-Woolley, March 18, 2003 (21 people attended)

Wenatchee, March 20, 2003 (5 people attended)

Bellevue, March 25, 2003 (21 people attended)

Seattle, March 27, 2003 (25 people attended)

The two- to three-hour scoping meetings were held in an open house format. The meetings began with a 30-minute presentation in which NPS and WDFW biologists discussed preliminary issues, the EIS process, and expectations for the meeting. Following the presentation, the participants broke into smaller work groups where facilitators assisted in discussions about issues, objectives, and preliminary alternatives. Public comments and concerns were recorded. The public comment period ended on April 18, 2003.

Issues and concerns were captured at public meetings and in subsequent written comments and emails. A Public Scoping Report was prepared based on these comments and is part of the administrative record for this plan/EIS. Formally, the NPS received more than 160 comments during the scoping meetings and from letters sent to the NPS.

The NPS used these comments in developing this plan/EIS. Based in part on public comment, the Technical Advisory Committee determined the need to perform the lake-by-lake analysis because each lake is so unique. Criteria used in the lake-by-lake analysis included fishing potential ratings assigned by user groups. The public also expressed a concern that the analysis occur on a landscape scale, so the Technical Advisory Committee took a broad look at lakes in the North Cascades Complex and selected a representative number of lakes to remain fishless under each alternative (see the "Alternatives" chapter for details about the alternatives).

Public Notification

The notice of intent to prepare an environmental impact statement was published in the *Federal Register* on January 16, 2003.

A brochure was mailed in early March 2003 to the project's preliminary mailing list of government agencies, organizations, businesses, and individuals. The brochure summarized the purpose of and need for a fishery management plan for the North Cascades Complex, the objectives for this plan/EIS, and history of mountain lakes fishery management. The brochure also contained important information (dates/times/locations) about the public scoping meetings.

A project website (www.nps.gov/noca/highlakes.htm) was created in January 2003 and is periodically updated with new information.

A news release for the public scoping meetings was sent on February 14, 2003, to the following news media: Seattle Times, Seattle Post Intelligencer, Chelan Mirror, Wenatchee World, Associated Press, Everett Herald, River Post, Argus, Spokane Chronicle, Bellingham Herald, Skagit Valley Herald, and Lynden Tribune.

AGENCY CONSULTATION

USDA—FOREST SERVICE

Mount Baker-Snoqualmie, Wenatchee, and Okanogan National Forests adjoin the North Cascades Complex. The Forest supervisors for these units have been regularly briefed on research results and the planning process. The forests have chosen not to be directly involved in the planning process for this plan/EIS, having stated that the WDFW manages the mountain lakes fishery on Forest Service lands.

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

Consultation with the WDFW began with a meeting in Sedro-Woolley, Washington, on October 1, 2002. During the meeting, it was determined that Mark Downen, inland fisheries biologist, would be the principal representative for the department. Mr. Downen requested that Bob Pfeifer, currently with the WDFW (formerly an inland fisheries management biologist and high lakes fishery manager with WDFW), also be involved because of his extensive experience in mountain lakes fishery management. The WDFW agreed to serve as a cooperating agency in the NEPA process. The regional director for the WDFW, Bob Everitt, is the principal contact for policy issues, and the inland fisheries biologist, Mark Downen, is the contact for technical issues. The correspondence documenting the role of the department as a cooperating agency is contained in the project's administrative record.

On July 17, 2003, Roy Zipp, Natural Resources Specialist of the North Cascades Complex, consulted with Cynthia Pratt, the WDFW coordinator for *Washington State Environmental Protection Act* (SEPA) and NEPA issues, to determine whether the NEPA process would suffice for the Washington SEPA. Ms. Pratt followed up the phone conversation in writing with SEPA-related materials and guidance for producing an environmental impact statement that meets the SEPA requirements.

U.S. ENVIRONMENTAL PROTECTION AGENCY

Discussions with the U.S. Environmental Protection Agency (EPA) began following their review of the notice of intent. Tom Connor, EPA environmental specialist, requested (via a telephone conversation with Roy Zipp on March 6, 2003) that he be included in all email correspondence. Mr. Connor also requested that the NPS include in their impact analysis (1) water quality, nonnative fish as pollutants; and (2) impacts to bull trout from downstream dispersal. Mr. Connor also recommended consultations with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Since that initial phone call, Mr. Connor was included on all email correspondence, including Technical Advisory Committee discussions. In a subsequent phone conversation between Roy Zipp and Tom Connor on July 17, 2003, Mr. Connor and Mr. Zipp discussed the need to document, in writing, that EPA had been consulted. Mr. Connor said that such written documentation was not necessary; continued dialogue via email would suffice, and he was looking forward to reviewing the draft plan/EIS.

U.S. FISH AND WILDLIFE SERVICE

The U.S. Fish and Wildlife Service was first notified of the proposed plan/EIS for the North Cascades Complex at the start of the scoping process. Letters were

sent to several regional offices and various personnel. No comments or feedback were received. Informal consultations with the service began in the summer of 2003, with a written request for an up-to-date species list and any information on the current status on the westslope cutthroat trout. The U.S. Fish and Wildlife Service requires a biological assessment that evaluates the impacts of proposed actions on listed species. They also recommended evaluating impacts to candidate species, since those species could be listed in the future. The service suggested that federal agencies, particularly the NPS, should be proactive in its efforts to prevent listing of species. Both the letter of request from the NPS and the reply from the U.S. Fish and Wildlife Service are included in appendix C. Also included in appendix C are tables listing special status species in the North Cascades Complex. Discussions with the U.S. Fish and Wildlife Service continue, with Linda Saunders as the principal contact.

NATIONAL MARINE FISHERIES SERVICE

Informal consultations with the National Marine Fisheries Service (NOAA Fisheries) began in the summer of 2003 with a telephone conversation with Tom Sibley of the Habitat Conservation Division. Mr. Sibley recommended that the NPS evaluate impacts to Chinook salmon (threatened) and Coho salmon (candidate). When asked if the National Marine Fisheries Service would like to receive a written request for their input, Mr. Sibley stated that the phone dialogue would suffice and pledged further technical assistance with the biological assessment, as needed.

NATIVE AMERICAN TRIBES

A public scoping letter requesting input was sent to the following tribes on March 31, 2003: Yakama Nation, Skagit System Cooperative, Nlakapamux National Tribal Council, Sauk-Suiattle Indian Tribe, Nooksack Tribal Office, and Colville Confederated Tribes. Mr. Larry Campbell, of the Swinomish Tribe, was the single tribal representative who responded during public scoping. Mr. Campbell expressed the concern that if any ground disturbance could occur from high lakes fishing activities, there should be compliance with section 106 of the *National Historic Preservation Act*.

Further consultations with the Skagit and Swinomish tribes were conducted by park archeologist, Bob Mierendorf, to determine whether or not the widespread belief that stocking is a modern practice that was not performed by native people. All responded that they had never heard of stocking prior to European settlement, though several individuals suggested it might have been possible. Based on this response, the decision was made to dismiss ethnographic resources, including the cultural practice of stocking, as an issue in this plan/EIS.

WASHINGTON STATE HISTORIC PRESERVATION OFFICE

The Washington State Historic Preservation Office (SHPO) was consulted in the summer of 2003 regarding their cultural resource and ethnographic concerns

related to mountain lakes fishery management. The SHPO did not envision any concerns for the various actions under consideration but expressed interest in receiving appropriate correspondence.

U.S. GEOLOGICAL SURVEY

Early in the planning process, the U.S. Geological Service (USGS) Forest Range and Experiment Station expressed its decision to not be involved in this plan/EIS in order to maintain scientific objectivity. This is because scientists from the USGS and Oregon State University completed a long-term research study to determine how continued stocking practices would affect native biota in mountain lakes in the North Cascades Complex (see the “Purpose of and Need for Action” chapter for a summary of how that research was used in this plan/EIS). Informal discussions with various staff members from the U.S. Geological Service have occurred throughout the planning process. These discussions have served to clarify elements of their research findings and on gathering additional data and information to support this plan/EIS.

LIST OF PREPARERS AND CONSULTANTS

Name	Title	Education/ Responsibility	Experience
National Park Service			
Roy Zipp	Natural Resource Specialist	B.A. Biology / Chemistry, M.S. Environmental Management (emphasis in water and air resources). Responsible for: park lead for project oversight; member, Technical Advisory Committee.	10 years
Ronald C. Holmes	Ecologist/Data Manager	M.S. Terrestrial Ecology. Responsible for: member, Technical Advisory Committee; compiling and maintaining mountain lakes database.	30 years
Reed Glesne	Supervisory Aquatic Ecologist	B.S. Natural Resources, M.S. Biology. Responsible for: member, Technical Advisory Committee; technical review.	30 years
David Jacob	Environmental Protection Specialist	J.D., Law; B.A., History. Responsible for: background / history and policy	2 years
Washington Department of Fish and Wildlife			
Mark Downen	Inland Fisheries Biologist	B.S., M.S. Environmental Science. Responsible for: member, Technical Advisory Committee; technical review.	6 years
Bob Pfeifer (formerly with Parametrix)	Inland Fisheries Management Biologist, Habitat Biologist	B.S., Biology, M.S., Fisheries. Responsible for: member, Technical Advisory Committee; technical review.	32 years
URS Corporation			
Nancy Van Dyke	Senior Consultant	B.A. Biology and Geography, M.S. Environmental Sciences. Responsible for: aquatic organisms, wildlife, special status species, general technical review	25 years
Patti Steinholtz	Writer / Editor, Communication Technician, and NEPA Planner.	B.A. Communications and English. Responsible for: general technical review.	9 years
Kim Cornelisse	Staff Wildlife Biologist	B.A. Biology. Responsible for: wildlife, special status species.	7 years
Wesley Toland	Staff Scientist	B.S. Environmental Studies. Responsible for: chapter 2 and appendix table reviews.	4 years
Rob Nielsen	Project Fisheries / Wildlife Biologist	Ph.D. Fisheries, M.S. Fisheries, B.S. Fisheries and Wildlife Science. Responsible for: fisheries/wildlife biology and habitat analysis.	30 years
Eric Doyle	Fisheries Biologist, Aquatic Ecologist	B.S. Marine Biology, Chemistry, M.M.A. Marine Affairs. Responsible for: developing the impacts assessment for plankton and macroinvertebrates.	7 years

Name	Title	Education/ Responsibility	Experience
Thomas G. Campbell	Senior Project Ecologist	B.S. Zoology, M.S. Marine Biology. Responsible for: coauthor of the monitoring plan and data consistency review.	28 years
TQ NEPA			
Heidi West	Principal	B.S. Biology, M.A. Science Communication, M.S. Biology, Ph.D. Environmental Science and Engineering. Responsible for: technical review.	22 years
Kathryn Joyner	Senior Analyst	B.S. Education, M.A. Archeology/Anthropology. Responsible for: cultural resources.	22 years
Erin Bissell	Natural Resources Analyst	B.S. Biology, Ph.D. Biology in progress. Responsible for: vegetation sections.	7 years
RED, Inc. Communications			
Susan Hale	Lead Technical Editor	Elementary Education, undergraduate courses. Responsible for: technical editing and publication management and coordination.	36 years
Juanita Barboa	Technical Editor	B.S. Technical Communication. Responsible for: technical editing and publication management and coordination.	14 years
Cheryl Priest	Desktop Publisher / Text Processor	Denver Medical and Business College. Responsible for: formatting and layout.	14 years
Matt Look	Graphic Artist	A.S. Graphic Design. Responsible for: map design, photo manipulation and design, and figure development.	10 years
Roy Reynolds	Illustrator	Art Center School. Responsible for: illustrations.	41 years
Kim Jacobson	Graphic Artist	B.F.A Graphic Design. Responsible for: cover and divider design.	24 years

LIST OF RECIPIENTS

This plan/EIS was sent to the agencies, organizations, and businesses listed below. This document was also mailed to other entities and individuals who requested a copy.

FEDERAL DEPARTMENTS AND AGENCIES

National Marine Fisheries Service

National Oceanic and Atmospheric Administration Fisheries

U.S. Army Corps of Engineers

U.S. Bureau of Indian Affairs

U.S. Department of the Interior

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

U.S. Forest Service, Mount Baker-Snoqualmie National Forest

U.S. Forest Service, Okanogan and Wenatchee National Forests

U.S. Geological Survey, Biological Resources Division

TRIBAL GOVERNMENTS AND ORGANIZATIONS

Nooksack Tribal Council

Sauk-Suiattle Tribe

Swinomish Indian Tribal Community

Upper Skagit Tribal Council

STATE OF WASHINGTON GOVERNMENT

United States Senate

Honorable Maria Cantwell

Honorable Patty Murray

United States House of Representatives

Honorable Doc Hastings, District 4

Honorable Rick Larsen, District 2

Honorable Norm Dicks, District 6

Washington State Senate

Honorable Linda Evans Parlette, 12th District
Honorable Mary Margaret Haugen, 10th District
Honorable Val Stevens, 39th District
Honorable Harriet Spanel, 40th District
Honorable Dale Brandland, 42nd District

House of Representatives

Honorable Chris Strow, 10th District
Honorable Barbara Bailey, 10th District
Honorable Cary Condotta, 12th District
Honorable Mike Armstrong, 12th District
Honorable Dan Kristiansen, 39th District
Honorable Kirk Pearson, 39th District
Honorable Dave Quall, 40th District
Honorable Jeff Morris, 40th District
Honorable Doug Ericksen, 42nd District
Honorable Kelli Linville, 42nd District

STATE OF WASHINGTON AGENCIES

Washington Department of Ecology
Washington Department of Fish and Wildlife
State Historic Preservation Office

WASHINGTON COUNTIES

Mayor, City of Chelan
Mayor, City of Sedro-Woolley
Mayor, City of Mount Vernon
Mayor, City of Wenatchee
Chelan County Commissioners
Skagit County Commissioners
Whatcom County Commissioners

STATE OF OREGON

Oregon State University, Forest Sciences Laboratory

ORGANIZATIONS AND BUSINESSES

Darrington Pharmacy
Earth Justice Legal Defense Fund
Kettle Range Conservation Group
King County Outdoor Sports Council
National Parks and Conservation Association
North Cascades Conservation Council
Seattle City Light
Sierra Club, Cascades Chapter
Student Conservation Assn. Inc.
The Henry M. Jackson Foundation
The Mountaineers
The Nature Conservancy
The Wilderness Society, Washington Chapter
Trail Blazers, Inc.
Trout Unlimited
University of Washington School of Aquatic Fishery Science
Washington Outfitters & Guide Association
Washington State Hi-Lakers
Washington State Sportsmen's Council
Washington Trout
Washington Wilderness Coalition
Western Land Exchange Project
Wilderness Watch, Montana

MEDIA AND PUBLICATIONS

Bellingham Herald
Skagit Valley Herald
The Herald
The Wenatchee World
SIGNPOST Magazine
Seattle Times-Science/Environmental Reporter

CANADA

British Columbia Ministry of Air, Land, and Water Protection

TECHNICAL ADVISORY COMMITTEE CHARTER FOR THE MOUNTAIN LAKES FISHERY MANAGEMENT PLAN AND ENVIRONMENTAL IMPACT STATEMENT

Mission: To advise and provide recommendations to the managers of the North Cascades National Park Service Complex on matters regarding fisheries data and analysis for a mountain lake fishery management plan and environmental impact statement.

Nature of Involvement: The committee will meet periodically for the duration of this environmental impact statement project to review and supplement necessary background information and data needed for the completion of an environmental impact statement. In addition, the committee will suggest analysis techniques and a range of management options that should be addressed as part of completing a defensible, resource-based planning process. Also, the committee will be asked to review draft documents related to the environmental impact statement process.

Members: Mark Downen (WDFW); Reed Glesne, Ron Holmes, Roy Zipp, Regina Rochefort (North Cascades Complex); Gary Larson (USGS-BRD); Bob Hoffman, Bill Liss (Oregon State University); Rob Nielsen (URS Corporation); Bob Pfeifer (WDFW); John Wullschleger (NPS/WRD); Facilitator; Recorder.

FUNCTIONS

1. To refine and further define the nature and scope (spatial/temporal) of ecological *issues*.[1]

2. To identify and recommend reasonable fishery management action*s* for park management to consider in developing alternatives for analyses.

3. To provide data to assist the park in describing the *affected environment*[1] for the environmental impact statement.

---

[1] The *italicized* words are part of the standard lexicon of the NEPA process; they are defined in the "Definitions" section below.

4. To assist in developing *impact analysis*[1] methodologies based upon best available science.

5. To review and comment on the analyses of *environmental consequences*[1] of management actions.

6. To provide technical guidance on presentations for public meetings.

7. To review and comment on the draft environmental impact statement and related documents.

DEFINITIONS

Issue – An environmental problem or relationship between a resource and an action. In an environmental impact statement, an issue is defined in the form of an *Issue Statement* that describes the resource(s) that would be affected by an action. Example: Anglers trample lakeshore vegetation.

Affected Environment – Resources expected to experience environmental impacts. The boundary or area for each resource must be delineated; it will vary substantially among resources. Example: riparian vegetation. For this environmental impact statement, the "boundary" for riparian vegetation might include all riparian vegetation around mountain lakes within the park.

Impact Analysis – The formal, objective process of predicting the degree to which a resource will be affected by each alternative. The prediction must include considerations of context, intensity, duration, and timing. Direct, indirect, and cumulative impacts must be analyzed.

Environmental Consequences – The direct, indirect, and cumulative consequences (impacts) of alternatives.

Canada
Mt. Baker Wilderness
Mt. Shuksan
North C
Nationa
(north
Baker Lake
Skagit River
Marblemount
Sauk River
Suiattle River
Darrington
Boulder River Wilderness
0
5
10
20

References

North C
Nationa
(north

REFERENCES

Adams, M., D.E. Schindler, and R.B. Bury

2000 Association of Amphibians with Characteristics of Montane Ponds," pp. 32-37. In *Inventory and Monitoring of Amphibians in North Cascades and Olympic National Parks, 1995–1998, Final Report.* R.B. Bury and M.J. Adams, eds. Prepared for the USDI National Park Service, Natural Resource Protection Program by USGS Forest and Rangeland Ecosystem Science Center, Corvallis, OR. 135 pp.

Adams, S.B., C.F. Frissell, and B.E. Reiman

2001 "Geography of invasion in mountain streams: Consequences of headwater lake fish introductions." Ecosystems 4(4):296-307.

American Wildlands; Clearwater Biodiversity Project; Idaho Watershed Project, Inc.; Montana Environmental Information Center; Pacific Rivers Council; Trout Unlimited (Madison-Gallatin Chapter); and B. Lilly

1998 Petition for a rule to list the westslope cutthroat trout (*Oncorhynchus clarki lewisi*) as threatened throughout its range. Office of Endangered Species, Fish and Wildlife Service, U.S. Department of the Interior, Washington, DC. http://www.wildlands.org/.

Anderson, J.D.

1972 "Phototactic behaviour of larvae and adults of two subspecies of Ambystoma macrodactylum." Herpetologica 28(3):222-226.

Bahls, P.

1990 Report of the high lakes fisheries project. Nez Perce National Forest and Idaho Department of Fish and Game. September.

Bats Northwest

2004 "Meet the Western Long-eared Myotis. Accessed online at http://www.batsnorthwest.org/batsArticle.asp?ID=56

Behnke, R.J.

1992 Native trout of western North America. Monograph 6. American Fisheries Society, Bethesda, MD.

2002 Trout and Salmon of North America. Chanticleer Press, Inc., New York, NY. 359 pp.

Bell, M.C.

1991 Fisheries Handbook of Engineering Requirements and Biological Criteria. US Army Corps of Engineers, Office of the Chief of Engineers, Portland, OR.

Berger, B.L., R.E. Lennon, and P.A. Gilderhus

1969 "Laboratory studies of antimycin A as a fish toxicant." In Investigations in Fish Control No. 26. U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Washington, DC.

Bettoli and Maceina

1996 "Sampling with Toxicants." In Fisheries Techniques, Second Edition. American Fisheries Society, Bethesda, MD.

Bilton, D.T., J.R. Freeland, and B. Okamura

2001 "Dispersal in freshwater invertebrates." *Annual Review of Ecology and Systematics* 32:159-181.

Blais, J.M., D.W. Schindler, D.C.G. Muir, L.E. Kimpe, D.B. Donald, and B. Rosenberg
1998 Accumulation of Persistent Organochlorine Compounds in Mountains of Western Canada. Nature 1998, 395, pp. 585-588.

Bohonak, A.J. and D.G. Jenkins
2003 Ecological and evolutionary significance of dispersal by freshwater invertebrates. Ecology Letters 6:783-796.

Bradford, D.F. and F. Tabatabai
1993 "Isolation of remaining populations of the native frog, Rana mucosa, by introduced fishes in Sequoia and Kings Canyon National Parks, California." Conservation Biology 7(4):882-888.

Brokes, B.
1999 Habitat Characteristics of Two Ambystomatids in Mountain Ponds of Mount Rainier National Park. M.S. Thesis, Oregon State University, Corvallis, OR, and Mount Rainier National Park, Ashford, WA.

Brönmark, Christer and Lars-Anders Hansson
1998 The Biology of Lakes and Ponds: the Biology of Habitats. New York: Oxford University Press. 216 pp.

Bury, R.B.
2002 Amphibians of North Cascades and Olympic National Parks. USGS Forest and Rangeland Ecosystem Science Center. Project No. 76.

Bury, R.B. and M.J. Adams, eds.
2000 *Inventory and Monitoring of Amphibians in North Cascades and Olympic National Parks, 1995–1998, Final Report.* Prepared for the USDI National Park Service, Natural Resource Protection Program by USGS Forest and Rangeland Ecosystem Science Center, Corvallis, OR. 135 pp.

Bury, R.B., M.J. Adams, R.S. Glesne, and R.E. Holmes
2000 "Conclusion: Status of amphibians in Olympic and North Cascades National Parks." Pages 53-56 In Inventory and Monitoring of Amphibians in North Cascades and Olympic National Parks, 1995–1998, Final Report. R.B. Bury and M.J. Adams (eds.). Prepared for the USDI National Park Service, Natural Resource Protection Program by USGS Forest & Rangeland Ecosystem Science Center. Corvallis, OR. 135 pp.

Chelan County
2000 Chelan County Comprehensive Plan. Amended December 2002.

Chelan County Information (CCI)
2003 July 16, 2003. Available on the internet at http://www.chelancounty.info/.

Chess, D.W., F. Gibson, A.T. Scholz, and R.J. White
1993 "The introduction of lahontan cutthroat trout into a previously fishless lake: feeding habits and effects upon the zooplankton and benthic community." Journal of Freshwater Ecology 8:215-225.

Christophersen, R. and R.C. Kuntz
2003 *A Survey of Bat Species Composition, Distribution, and Relative Abundance. North Cascades National Park Service Complex, Washington.* Technical Report NPS/NOCA/NRTR-2003/01.

Cole, D.N. and S.J. Trull
1992 Quantifying vegetation response to recreational disturbance in the North Cascades, Washington. Northwest Science 66(4):229-236.

Corn, P.S.
1998 "Effects of ultraviolet radiation on boreal toads in Colorado." *Ecological Applications*, 8:18-26.

Craig, D. and P.L. Williams
1998 Willow Flycatcher (*Empidonax traillii*). In The Riparian Bird Conservation Plan: a strategy for reversing the decline of riparian-associated birds in California. California Partners in Flight. Available online at http://www.prbo.org/calpif/htmldocs/riparian_v-2.html.

Crawford, B.A.
1979 The origin and history of the trout brood stocks of the Washington Department of Game. Washington Department of Game, Olympia, WA.

Crumb, S.E.
1978 Long term effects of fish stocking on the invertebrate communities of Steep Lake, Idaho. Masters Thesis. University of Idaho, Moscow, ID.

Cutler, J.
2001 Salmon Habitat Limiting Factors, Anadromous and Resident Salmonid Distribution, Water Resources Inventory Areas 3 and 4, Skagit and Samish River Watersheds. Washington State Conservation Commission, Lacey, WA.

Dawidowicz, P. and Z.M. Gliwicz
1983 Food of brook charr in extreme oligotrophic conditions of an alpine lake. Environmental Biology of Fish 8:55-60.

Derse, P.H. and F.M. Strong
1963 Toxicity of antimycin to fish. Nature 200(4906):600-601.

Desimone, S.M. and D.W. Hays
2004 Northern goshawk (*Accipter gentiles*). In E.M. Larsen, J.M. Azerrad, and N. Nordstrom, editors. Management Recommendations for Washington's Priority Species, Volume IV: Birds [Online]. Available at http://wdfw.wa.gov/hab/phs/voll4/nogo.pdf.

Divens, M., S. Bonar, and B. Pfeifer
2001 Trout Stocking in High Lakes: Reported Impacts and Implications for Washington State. Washington Department of Fish and Wildlife, Olympia, WA.

Donald, D.B, R.D. Vinebrooke, R.S. Anderson, J. Syrgiannis, and M.D. Graham
2001 "Recovery of zooplankton assemblages in mountain lakes from the effects of introduced sport fish." *Canadian Journal of Fisheries and Aquatic Sciences*, 58:1822-1830.

Donald, D.B., R.S. Anderson, and D.W. Mayhood
1994 "Coexistence of fish and large Hesperodiaptomus species (Crustacea: Calanoida) in subalpine and alpine lakes." *Canadian Journal of Zoology*, 72:259-261.

Douglas M.S.V., J.P. Smol, and W. Blake Jr.
1994 Marked post-18th century environmental change in high-arctic ecosystems. Science 266:416-419.

Downen, Mark
2004 North Cascades National Park High Lakes Fishery Management: Historic, Current, and Proposed Future Management of Sport Fish in High-Elevation Park Lakes. Washington Department of Fish and Wildlife. Technical Report FPT04-04. 64 pp.

Drake, D.C. and R.J. Naiman
2000 “An evaluation of restoration efforts in fishless lakes stocked with exotic trout.” *Conservation Biology*, 14(6):1807-1820.

Drost, C.A. and G.M. Fellers
1996 “Collapse of a regional frog fauna in the Yosemite area of the California Sierra Nevada.” *Conservation Biology*, 10(2):414-425.

Dunham, J.B., D.S. Pilliod, and M.K. Young.
2004 “Assessing the Consequences of Nonnative Trout in Headwater Ecosystems in Western North America.” Fisheries 29:18-26.

Dvornich, K.M., K.R. McAllister, and K.B. Aubry
1997 Amphibians and reptiles of Washington State: Location data and predicted distributions, Volume 2 in Washington State Gap Analysis - Final Report, (K.M. Cassidy, C.E. Grue, M.R. Smith and K.M. Dvornich, eds.), Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle. 146 pp.

Feltmate, B.W. and D.D. Williams
1989 Influence of Rainbow Trout (*Oncorhynchus mykiss*) on Density and Feeding Behaviour of a Perlid Stonefly. Can. J. Fish. Aquat. Sci. 46, 1575-1580.

Feltmate, B.W., D.D. Williams, and A. Montgomerie
1992 Relationship between Diurnal Activity Patterns, Cryptic Coloration, and Subsequent Avoidance of Predaceous Fish by Perlit Stoneflies. Can. J. Fish. Aquat. Sci. 49, 2630-2634.

Finlayson, B.J., R. Schnick, R. Cailteux, L. DeMong, W. Horton, W. McClay, and C. Thompson
2002 Potential of Antimycin A Use in Fisheries--Assessment of Reregistration. Fisheries (6): pp. 10-18.

Fukumoto, J.M.
1995 Long-toed salamander (*Ambystoma macrodactylum*) ecology and management in Waterton Lakes National Park. Masters thesis, The University of Calgary, Calgary, Alberta.

Funk, W.C. and W.W. Dunlap.
1999 “Colonization of high-elevation lakes by long-toed salamanders (*Ambystoma macrodactylum*) after the extinction of introduced trout populations.” *Canadian Journal of Zoology* 77:1759-1767.

Gilderhus, P.A., B.L. Berger, and R.E. Lennon
1969 “Field trials of antimycin A as a fish toxicant.” In *Investigations in Fish Control* No. 27. U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Washington, DC.

Gliwicz, Z.M. and M.G. Rowan
1984 Survival of Cyclops Abyssorum tatricus (Copepoda, Crustacea) in alpine lakes stocked with planktivorous fish. Limnology and Oceanography 29(6):1290-1299.

Goodman and Sojda
2004 “Applying Advanced Technologies for Adaptive Management and Decision Support in Natural Resources,” http://www.esg.montana.edu/esg/adaptive_mgmt_1.html accessed February 2004.

Graham, K., W. Bessie, A. Hoover, R. Bonar, R. Quinlan, J. Beck, and B. Beck
1999 Long-toed salamander year round habitat: habitat suitability index model, Version 5. Foothills Model Forest, Hinton, Alberta, Canada.

Graham, K.L. and G.L. Powell

1999 *Status of the Long-toed Salamander (Ambystoma macrodactylum) in Alberta*. Alberta Wildlife Status Report No. 22, Alberta Environmental Protection, Fisheries and Wildlife Management Division and Alberta Conservation Association, Edmonton, Alberta, Canada.

Green, D.M, H. Kaiser, T.F. Sharbel, J. Kearsley, and K.R. McAllister

1997 "Cryptic species of spotted frogs, *Rana pretosia* complex, in western North America." *Copeia* 1997(1):1-8.

Gresswell, R.E. and J.D. Varley

1988 Effects of a century of human influence on the cutthroat trout of Yellowstone Lake, pp. 45-52. In *Status and management of interior stocks of cutthroat trout, American Fisheries Society Symposium 4*, Gresswell, R.E. (ed.). American Fisheries Society, Bethesda, MD.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins

1991 An ecosystem perspective of riparian zones. Bioscience 41: 540-551.

Grumbine, R.E.

1994 What is ecosystem management? Conservation Biology. 8:27-38.

Hanson, M.A.

1990 "Responses of plankton, turbidity and macrophytes to biomanipulation in a shallow prairie lake." Ph.D. Dissertation. North Dakota State University, Fargo.

Hendee, J.C., Roger, N. Clark, and T.E. Dailey

1977 Fishing and Other Recreation Behavior at High Mountain Lakes in Washington State. USDA Forest Service Research Note, Pacific Northwest Forest and Range Experiment Station, publication PNW-304.

Hendee, J.C. and G.H. Stankey

1973 Biocentricity in Wilderness Management. *BioScience* 23(9): 535-538.

Hendee, J.C. and C.P. Dawson

2002 *Wilderness Management: Stewardship and Protection of Resources and Values*, 3rd edition. Fulcrum Publishing, Golden, CO. 640 pp.

Hoffman, R.L. and D.S. Pilliod

1999 The Ecological Effects of Fish Stocking on Amphibian Populations in High-Mountain Wilderness Lakes. United States Geological Survey, Biological Resources Division, Forest and Rangeland Ecosystem Science Center, Corvallis, OR.

Hoffman, R.L., G.L. Larson, and B.J. Brokes

2003 "Habitat segregation of *Ambystoma gracile* and *Ambystoma macrodactylum* in mountain ponds and lakes, Mount Rainier National Park, Washington, USA." *Journal of Herpetology* 37(1):24-34.

Hoffman, R.L., W.J. Liss, G.L. Larson, E.K. Deimling, and G.A. Lomnicky

1996 "Distribution of nearshore macroinvertebrates in lakes of the Northern Cascades Mountains, Washington, USA." *Archives of Hydrobiology* 136(3):363-389.

Hospodarsky, D. and P.J. Brown

1992 *Assessment of the Effects of Angling on High Lake Riparian Environments, North Cascades National Park Service Complex*. Cooperative Park Studies Unit, College of Forestry, Oregon State University, Corvallis, OR. Study developed and administered under NPS Cooperative Agreement CA-900080006-11. File Code: CPSU/OSU 92-1. 47 pp.

Houf, L.J. and R.S. Campbell

1977 “Effects of antimycin A and rotenone on macrobenthos in ponds.” In *Investigations in Fish Control* No. 80. U.S. Department of the Interior, Fish and Wildlife Service, Washington DC.

Huyhn, M.L., L. Takats and L. Wilson

2002 *Long-Toed Salamander (Ambystoma macrodactylum) Monitoring Study in Alberta: Summary Report 1998–2001.* Alberta Species at Risk Report No. 36. Alberta Sustainable Resource Development, Fish and Wildlife Division – Resource Status and Assessment Branch.

Jacobi, G.Z. and D.J. Degan

1977 “Aquatic macroinvertebrates in a small Wisconsin trout stream before, during, and two years after treatment with the fish toxicant antimycin.” In *Investigations in Fish Control* No. 81. U.S. Department of the Interior, Fish and Wildlife Service, Washington DC.

Jennings, M.R.

1996 “Status of Amphibians.” Chapter 31 in, Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. II, Assessments and scientific basis for management options. University of California, Davis, Centers for Water and Wildland Resources.

Johnston, J.M.

1973 High Lake Survey Report. Olympic National Forest. Part II. 1973. Washington Department of Game. Fisheries Management Division. 175 pages.

Karr, J.R. and D.R. Dudley

1981 Ecological perspective on water quality goals. *Environmental Management*, 5: 55-68.

Karr, J.R.

2000 Health, integrity and biological assessment: the importance of measuring whole things, pp. 209-226. From Ecological integrity: integrating environmental conservation and health. D. Pimintel, L. Westera, and R.F. Noss, editors. Island Press.

Kellert, S.R.

1976 Study on the Attitudes of Americans Toward Wildlife. Yale University.

Knapp R.A.

1996 “Non-Native Trout in Natural Lakes of the Sierra Nevada: An Analysis of Their Distribution and Impacts on Native Aquatic Biota”. Chapter 8 in, *Sierra Nevada Ecosystem Project: Final Report to Congress, Addendum, Assessments and scientific basis for management options.* University of California, Davis, Centers for Water and Wildland Resources.

Knapp, R.A. and K.R. Matthews

1998 “Eradication of nonnative fish by gill netting from a small mountain lake in California.” *Restoration Ecology* 6(2):207-213.

2000 “Non-native fish introductions and the decline of the mountain yellow-legged frog from within protected areas.” *Conservation Biology* 14(2):428-438.

Landres, P., S. Meyer and S. Matthews

2001 “The wilderness act and fish stocking: An overview of legislation, judicial interpretation and agency implementation.” *Ecosystems* 2001(4):287-295.

Larrison, E.J.

1976 *Mammals of the Northwest.* Seattle Audubon Society, Seattle, WA.

Larson, G.L., C.D. McIntire, R.E. Truitt, W.J. Liss, R.L. Hoffman, E.L. Deimling, and G.A. Lomnicky
1998 "Phytoplankton assemblages in high-elevation lakes in the northern Cascade Mountains, Washington State, USA." *Archives of Hydrobiology* 142(1):71-93.

Larson, G.L., G.A. Lomnicky, R.L. Hoffman, W.J. Liss, and E.L. Deimling
1999a "Integrating physical and chemical characteristics of lakes into the glacially influenced landscape of the northern Cascade Mountains, Washington State, USA." *Environmental Management* 24(2):219-228.

Larson, G.L., C.D. McIntire, R.W. Jacobs, and R. Truitt
1999b "Temporal variations of water quality and the taxonomic structures of phytoplankton and zooplankton assemblages in mountain lakes, Mount Rainier National Park, Washington USA." *Lake and Reservoir Management* 15(1):148-158.

Larson, G.L. and R.L. Hoffman
2002 "Abundances of northwestern salamander larvae in montane lakes with and without fish, Mount Rainier National Park, WA." *Northwest Science* 76(1): 35-40.

Leavitt, P.R., D.E. Schindler, A.J. Paul, A.K. Hardie, and D.W. Schindler
1994 "Fossil pigment records of phytoplankton in trout-stocked alpine lakes." *Canadian Journal of Fisheries and Aquatic Sciences* 51:2411-2423.

Leonard, W.P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm
1993 Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, WA. 168 pp.

Lewis, J.C. and D.W. Stinson
1998 Washington State status report for the fisher. Washington Department of Fish and Wildlife. Olympia. 64 pp.

Licht, L.E.
1975 "Growth and food of larval *Ambystoma gracile* from a lowland population in southwestern British Columbia." *Canadian Journal of Zoology* 53:1716-1722.

Liss, W.J., G.L. Larson, E.K. Deimling, L.M. Ganio, R.L. Hoffman, and G.A. Lomnicky
1998 Factors Influencing the Distribution and Abundance of Diaptomid Copepods in High-elevation lakes in the Pacific Northwest, USA. *Hydrobiologia* 379:63-75.

Liss, W.J., G.L. Larson, E.K. Deimling, L. Ganio, R. Gresswell, R. Hoffman, M. Kiss, G.A. Lomnicky, C.D. McIntire, R. Truitt, and T. Tyler
1995 *Ecological Effects of Stocked Trout in Naturally Fishless High Mountain Lakes: North Cascades National Park Service Complex*, WA, USA. Technical Report NPS/PNROSU/NRTR-95-03. USDI National Park Service, Pacific Northwest Region, Science and Technology. Seattle, WA. March. 285 pp.

Liss, W.J., G.L. Larson, and R.L. Hoffman, eds.
2002 *Ecological Impact of Introduced Trout on Native Aquatic Communities in Mountain Lakes: Phase III Final Report.* Prepared for the USDI National Park Service, Pacific Northwest Region, North Cascades National Park Service Complex by USGS Forest and Rangeland Ecosystem Science Center. Corvallis, OR. 102 pp.

Liss, W.J., G.L. Larson, T.J. Tyler, L. Ganio, R. Hoffman, E.A. Deimling, G.A. Lomnicky, C.D. McIntire, and R. Truitt

1999 *Ecological Effects of Stocked Trout in Naturally Fishless High Mountain Lakes: North Cascades National Park Service Complex*, WA, USA: Phase II. Technical Report NPS/CCSSOOSU/NRTR-98/01. USDI National Park Service, Pacific Northwest Region, Science and Technology. Seattle, WA. 133 pp.

Llewellyn, R.L. and C.R. Peterson

1998 Distribution and relative abundance and habitat associations of amphibians and reptiles on Craig Mountain, Idaho. Idaho Bureau of Land Management, Technical Bulletin No. 98-15, Boise, ID.

Louter, D.

1998 Contested Terrain: North Cascades National Park Service Complex, An Administrative History. USDI National Park Service. Seattle, WA. 338 pp. (http://www.nps.gov/noca/adhi.htm)

2003 NPS Historian. White paper. The Fish-Stocking Controversy: North Cascades National Park Service Complex, 1968-2003. March, 2003. (http://www.nps.gov/noca/whitepaper.htm).

Luecke, C.

1990 "Changes in abundance and distribution of benthic macroinvertebrates after introduction of cutthroat trout into a previously fishless lake." *Transactions of the American Fisheries Society* 119:1010-1021.

Luxenberg, Gretchen

1986 *Historic Resource Study*. U.S. Department of the Interior: National Park Service, Pacific Northwest Region, 1986.

1989 Multiple Property National Register Nomination: Historic Resources of the North Cascades National Park Service Complex. U.S. Department of the Interior: National Park Service, Pacific Northwest Region, 1989.

Mathews, D.

1999 *Cascade-Olympic Natural History: A Trailside Reference*. 2nd edition. Portland, OR: Raven Editions. 623 pp.

Matthews, K.R., R.A. Knapp, and K. Pope

2001a Garter Snake Distributions in High-Elevation Aquatic Ecosystems: Is There a Link with Declining Amphibian Populations and Nonnative Trout Introductions? *Journal of Herpetology*. Vol. 36, No. 1,pp 16-22.

Matthews, K.R., K.L. Pope, H.K. Preisler, and R.A. Knapp

2001b "Effects of nonnative trout on Pacific treefrogs (*Hyla regilla*) in the Sierra Nevada." *Copeia* 2001(4):1130-1137.

Maxell, B.A.

2000 Management of Montana's Amphibians: A Review of Factors that may Present a Risk to Population Viability and Accounts on the Identification, Distribution, Taxonomy, Habitat Use, Natural History and the Status and Conservation of Individual Species. A report to USDA Forest Service, Northern Regional Office (Region 1). Submitted under Order No. 43-0343-0-0224.

McNaught, A.S., D.W. Schindler, B.R. Parker, A.J. Paul, R.S. Anderson, D.B. Donald, and M. Agbeti

1999 "Restoration of the food web of an alpine lake following fish stocking." Limnology and Oceanography 44(1):127-136.

Merrit, R.W. and K.W. Cummins

1996 An Introduction to the Aquatic Insects of North America, 3rd edition. Dubuque, Iowa: Kendall-Hunt Publishing Co. 862 pp.

Morrison, B.R.S.

1987 "Use and effects of piscicides," pp. 47-52. In Angling and wildlife in freshwaters, proceedings of a symposium organized by the Scottish Freshwater Group and the British Ecological Society. P. S. Maitland and A. K. Turner (eds.). University of Stirling, England.

National Park Service (NPS) (U.S. Department of the Interior)

1986 People of the North Cascades. 1986. North Cascades National Park Service Complex, Cultural Resources Division, Pacific Northwest Region, by R. Mierendorf. Seattle, WA. 197 pp.

1988a Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis. NERC 88/29, AFESC TR 88.14 Engineering and Services Center, U.S. Air Force, U.S. Fish and Wildlife Service. June.

1988b *General Management Plan: North Cascades National Park, Ross Lake National Recreation Area, Lake Chelan National Recreation Area.* U.S. Government Printing Office: 1988—573-038/60,031 Region No. 8. 77pp.

1989 Wilderness Management Plan. Unpublished Plan completed March 20, 1989. 70 pp.

1992 Visitor Services Project, Stehekin, North Cascades National Park and Lake Chelan National Recreational Area. Report 42. Cooperative Park Studies Unit, Department of Forest Resources, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, ID.

1994 Report to Congress: Report on Effects of Aircraft Overflights on the National Park System. Prepared Pusuant to Public Law 100-91, The National Parks Overflights Act of 1987. National Park Service. September 12. Accessed at http://www.nonoise.org/library/npreport/intro.htm.

1995 *Final General Management Plan and Environmental Impact Statement for Lake Chelan National Recreational Area.* http://nps.gov/noca/lcgmp.htm.

1997 *NPS 28: Cultural Resources Management Guidelines.* Release Number 5. U.S. Government Printing Office: 1997-521-495/90265. 350 pp.

1998 An Updated Summary Statement of the Archeology of the North Cascades National Park Service Complex, R. Mierendorf. (www.nps.gov/noca/archeology1.htm.)

1999a *Final Resource Management Plan for North Cascades National Park Service Complex.* 281 pp. (North Cascades National Park).

1999b North Cascades Draft Environmental Assessment for an Accessible Fishing Facility. Ross Lake National Recreation Area, North Cascades National Park Service Complex. March.

1999c *Reference Manual 41: Wilderness Preservation and Management.*

2000a *Strategic Plan for the North Cascades National Park Service Complex (North Cascades National Park, Ross Lake National Recreation Area, Lake Chelan National Recreation Areas).* For Federal Fiscal Years 2001 to 2005 (October 1, 2000-September 5, 2005).

2000b *Environmental Assessment for Using a Pesticide for Brook Trout Restoration – Great Smoky Mountains National Park.* Tuckaseigee Chapter of Trout Unlimited Web Site. http://www.smokyonthefly.com/tucktu/brook_trout_proposal.htm IN: WDFW 2004.

2001a *Management Policies 2001.* U.S. Department of the Interior, National Park Service. Washington, DC. 137 pp.

2001b *Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision-making,* and Handbook. Washington, DC. Available on the Internet at <http://www.nps.gov/policy/DOrders/DOrder12.html> and <http://www.nps.gov/policy/DOrders/RM12.pdf>.

2001c Preliminary Restoration of Mountain Yellow-legged Frogs, Environmental Assessment. U.S. Department of the Interior, National Park Service, Sequoia and Kings Canyon National Parks. Three rivers, CA. 35 pp.

2003a Estimates of lakeshore vegetation cover made by North Cascades National Park staff and provided by Roy Zipp, NPS Biologist at North Cascades National Park Service Complex.

2003b Long-Term Ecological Monitoring Conceptual Plan. Accessed online at http://www.nps.gov/noca/Ltem/TV_Text.htm on December 29, 2003.

2003c Visitor use statistics/backcountry permit data. Accessed online athttp://www2.nature.nps.gov/stats/.

2004 "Establish a Non-Native Trout Removal Program in North Cascades National Park." Unpublished proposal written by Roy Zipp, Biologist, and submitted in FY 2004 to NPS for funding consideration.

Nilsson, N.A. and B. Pejler
1973 On the relation between fish fauna and zooplankton composition in north Swedish lakes. Institute of Freshwater Research, Drottingholm 53:51-77.

Norlin, A.
1967 Terrestrial insects in lake surfaces: Their availability and importance as fish food. Institute of Freshwater Research, Drottingholm 47:39-55.

North Cascades Conservation Council (NCCC)
2004 NCCC website: http://www.northcascades.org.

Northcote, T.G., C.J. Walters, and J.M.B. Hume
1978 Initial impacts of experimental fish introductions on the macrozooplankton of small oligotrophic lakes. Internationale Vereinigung Fuer Theorerische Und Angewandte Limnologie Verhandlungen 20:2003-2012.

Nussbaum, R.A., E.D. Brodie, and R.M. Storm
1983 *Amphibians and Reptiles of the Pacific Northwest.* Moscow, ID: University of Idaho Press.

Office of Financial Management (OFM)
2002 Historical/Current Data Set: Total Resident Population by Year for Counties, Washington, 1960 to 2001 (Updated Jan 2002) - Annual July Update. http://www.ofm.wa.gov/pop/coseries/index.htm. Washington State County Population Projections, Growth Management Act Population Projections, Intermediate Series, by State and County. http://www.ofm.wa.gov/pop/gma/countypop.pdf.

Olive, J.
1953 A comparative limnological study of two northern Colorado mountain lakes. The Ohio Journal of Science 53(3)159-167.

Page, L.M. and B.M. Burr

1991 A field guide to freshwater fishes of North America north of Mexico. The Peterson Field Guide Series, volume 42. Houghton Mifflin Company, Boston, MA.

Parker, B.R., D.W. Schindler, D.B. Donald, and R.S. Anderson

2001 "The effects of stocking and removal of a nonnative salmonid on the plankton of an alpine lake." *Ecosystems* 2001(4):334-345.

Parker, B.R., F.M. Wilhelm, and D.W. Schindler

1996 "Recovery of *Hesperodiaptomus arcticus* populations from diapausing eggs following elimination by stocked salmonids." *Canadian Journal of Zoology* 74:1292-1297.

Paul, A.J. and D.W. Schindler

1994 Regulation of rotifers by predatory calanoid copepods (subgenus Hesperodiaptomus) in lakes of the Canadian Rocky Mountains. Canadian Journal of Fisheries and Aquatic Sciences 51:2520-2528.

Peck, S.B.

1975 Amphipod dispersal in the fur of aquatic mammals. Canadian Field Naturalist. 89: 181-182.

Petranka, J.W.

1998 *Salamanders of the United States and Canada.* Smithsonian Institution Press, Washington, DC.

Pilliod, D.S. and C.R. Peterson

2000 "Evaluating Effects of Fish Stocking on Amphibian Populations in Wilderness Lakes." In, Cole, D.N., S.F. McCool, W.T. Borrie, and J. O'Loughlin, comps. Wilderness science in a time of change conference – Volume 5: Wilderness ecosystems, threats and management; May 23-27, 1999. Missoula MT. Proceedings RMRS-P-15-VOL-5 Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

2001 "Local and landscape effects of introduced trout on amphibians in historically fishless watersheds." *Ecosystems* 2001(4):322-333.

Rabe, R.W. and R.C. Wissmar

1969 "Some effects of antimycin in an oligotrophic lake." *The Progressive Fish-Culturist* 31:163.

Reid, G.K. and R.D. Wood

1976 *Ecology of Inland Waters and Estuaries*. 2nd edition. New York: Van Nostrand Company. 485 pp.

Reimers, N.

1958 Conditions of existence, growth and longevity of brook trout in a high altitude lake of the eastern Sierra Nevada. California Fish and Game 44(4):319-333.

Richardson, S., D. Hays, R. Spencer, and J. Stofel

2000 Washington State Status Report for the Common Loon. Washington Department of Fish and Wildlife, Olympia. 53 pp.

Rosenlund, B.D. and D.R. Stevens

2002 *Application of Antimycin (Fintrol) to Alpine Lakes and Streams in Rocky Mountain National Park and the Headwaters of the Leadville National Fish Hatchery to Establish Populations of Greenback and Colorado River Cutthroat Trout. Draft Report.* U.S. Fish and Wildlife Service, Lakewood CO. 31 pp.

Schell, V. A. and J.J. Kerekes

1989 Distribution, abundance and biomass of benthic macroinvertebrates relative to pH and nutrients in eight lakes of Nova Scotia, Canada. Water Air Soil Poll. 46:359.

Schindler, D. E., R. A. Knapp, and P. R. Leavitt

2001 "Alteration of nutrient cycles and algal production resulting from fish introductions into mountain lakes." *Ecosystems* 2001(4):308-321.

Schnick, R.A.

1974 A review of the literature on the use of antimycin in fisheries. U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Fish Control Laboratory, LaCrosse, WI.

Scott, W.B. and E.J. Crossman

1973 Freshwater Fisheries of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa.

Seattle Audubon Society (SAS)

2002 The Bird Web: Seattle's Online Guide to the Birds of Washington State. Accessed online at http://www.birdweb.org/birdweb/species.asp?id=281.

2004 The Bird Web: Merlin. Accessed on-line at http://www.birdweb.org/birdweb/species.asp?id=112 on January 9.

Shields, B.A. and W.J. Liss

2003 Genetic Diversity of Long-Toed Salamanders (*Ambystoma macrodactylum*) in High-Elevation Lakes. Final Report (Unpublished) Submitted to Seattle City Light on May 6, 2003. Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR.

Skagit County

2000 Skagit County Comprehensive Plan. July 24.

Smith, C.J.

2002 Salmon and Steelhead Habitat Limiting Factors in WRIA 1, the Nooksack Basin. Washington State Conservation Commission, Lacey, WA.

Sondergaard, M., E. Jeppesen, E. Mortensen, E. Dall, P. Kristensen, and O. Sortkjaer

1990 Phytoplankton biomass reduction after planktivorous fish reduction in a shallow, eutrophic lake : a combined effect of reduced internal P-loading and increased zooplankton grazing. Hydrobiologia 200/201: 229-240.

Stevens-Ayers, Theresa

1997 The effect of temperature and food level on the expression of paedomorphosis and the occurrence of paedomorphosis along an elevational gradient in the northwestern salamander, Ambystoma gracile. M.S. Thesis, University of Washington, College of Forest Resources, Seattle, WA.

Stoltz, J. and J. Schnell

1991 The Wildlife Series: Trout. Stackpole Book, Harrisburg, PA.

Tiffan, K.F. and E.P. Bergerson

1996 Performance of antimycin in high-gradient streams. North American Journal of Fisheries Management 16:465-468.

Trotter, P.C.

1987 Cutthroat, native trout of the west. Colorado Associated University Press, Boulder, CO.

Tyler, T., W. Liss, M. Ganio, G.L. Larson, R. Hoffman, E. Deimling, and G.A. Lomnicky
1998a Interaction between introduced trout and larval salamanders (*Ambystoma macrodactylum*) in high-elevation lakes. Conservation Biology 12:94-105.

Tyler, T., W.J. Liss, R.L. Hoffman, and L.M. Ganio
1998b "Experimental analysis of trout effects on survival, growth, and habitat use of two species of *Ambystomatid* salamanders." *Journal of Herpetology* 32(3):345-349.

Tyler, T.J., W.J. Liss, G.L. Larson, L.M. Ganio
2002 Abundance and behavior of larval long-toed salamanders (*Ambystoma macrodactylum*) in naturally fishless lakes and lakes with non-reproducing populations of introduced trout in Northern Cascade Mountains, Washington, USA. Chapter 1 in Liss et al., eds. Ecological Impact of Introduced Trout on Native Aquatic Communities in Mountain Lakes, July 2002.

Tyler, T.J., C.D. McIntire, B. Samora, R.L. Hoffman, and G.L. Larson
2003 *Inventory of aquatic breeding amphibians, Mount Rainier National Park, 1994-1999.* U.S. Department of the Interior, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvalis, OR.

U.S. Environmental Protection Agency (EPA)
2004 National Guidance. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2: Risk Assessment and Fish Consumption Limits. Office of Science and Technology. Available at: <http://www.epa.gov/ost/fishadvice/volume2/>

U.S. Geological Survey (USGS)
1995 Long-eared Myotis (*Myotis evotis*). Accessed online at http://www.npwrc.usgs.gov/resource/distr/others/nddanger/species/myotevot.htm.

Walters, C.J. and R.E. Vincent
1973 "Potential productivity of an alpine lake as indicated by removal and reintroduction of fish." *Transactions of the American Fisheries Society* 102:675-697.

Washington Department of Fish and Wildlife (WDFW), Washington Fish and Wildlife Commission
1995 Washington Department of Fish and Wildlife Goals, Policies, and Objectives. Olympia, WA. February 2. 16 pp.

2001 *Washington Department of Fish and Wildlife's High Lakes Fishery Management Program.* Report Number 553-3766-001. Prepared by Parametrix (B. Pfeifer, M. Swayne, and B. Curtis). Olympia, WA. January 6. 272 pp.

2002 List of federal and state sensitive species. Available at www.wa.gov/wdfw/wlm/diversty/soc/soc.htm>

2003 North Cascades National Park High Lakes Fishery Management Program. Draft Report. Mark R. Downen, Area Inland Biologist, Washington Department of Fish and Wildlife, La Conner District Office. June 9.

Washington Department of Revenue (WDOR)
2003 Taxable Retail Sales Comparison for All Cities and Unincorporated Counties. Taxable Retail Sales and Unit Count Calendar Year, 2002. Available online at http://dor.wa.gov/content/Statistical_Reports/stats_taxretail.asp.

Washington Department of Transportation (WDOT)
2002 Annual Traffic Report. 222 pp. Available online at http://www.wsdot.wa.gov/mapsdata/.

Washington Employment Security Department (WESD)
2003 Labor Market Information, Selected Economic Data. Available online at http://www.wa.gov/esd.

Washington Gap Analysis Program (WAGAP)
1997 Breeding Bird Distribution Models. Accessed online at http://www.wdfw.wa.gov/wlm/gap/birds.htm.

2003 Predicted Distribution Map for Merlin (*Falco columbarius*). Translated from the Washington Gap Analysis Bird Volume by Uchenna Bright. Accessed online at http://www.fish.washington.edu/naturemapping/maphtml/bfaco.html on January 9, 2004.

Water Environmental Services, Inc. (WESI)
1993 Olympic National Forest Wilderness Lake Survey: Goat Lake Phytoplankton-Zooplankton Community Analysis. Prepared for the U.S. Department of Agriculture-Forest Service, Olympic National Forest.

Whatcom County
1998 Whatcom County Comprehensive Plan.

Wydoski, R. S. and Whitney, R. R.
2003 Inland Fishes of Washington. Species Keys and Life History Accounts: Lampreys. Second Edition, Revised and Expanded. Published by the American Fisheries Society, Bethesda, Maryland, in association with University of Washington Press, Seattle, WA.

PERSONAL COMMUNICATION

Bivin, M., North Cascades National Park Plant Ecologist
Personal communication with E. Bissell, TQNEPA. January 5 and June 22, 2004.

Boiano, Danny, Fishery Biologist. Sequoia Kings Canyon National Park
Personal communication. September 2003.
Personal communication. October 14, 2003.

Bransom, Sarah, NPS, Environmental Quality Division
Personal communication (email) regarding angler numbers. January 3, 2004.

Christerphersen, Roger, NPS Wildlife Biologist
Personal communication. August 1, 2003.

Cliff, Courtney, Stehikin Valley Ranch
Personal communication. August 9, 2003.

Conner, Ed, Seattle City Light
Personal communication. June 19, 2003.

Crisafulli, C.
Personal Cummunication (telephone) with R. Nielsen, URS, Seattle, WA, regarding Dr. Crisafulli's recent research on Northwest salamander predation by brook trout in Mt. St. Helen's Volcanic Monumnet lakes. March 2003.

Downen, Mark, Fishery Biologist, Washington Department of Fish and Wildlife
Personal communication. November 14, 2002.
Personal communication. June 15, 2003.
Personal communication. January 20, 2004; June 21, 2004; and July 7, 2004 regarding fish and special status species presence, conditions, thresholds.

Fowler, C.
Memorandum to NPS staff at the North Cascades Complex regarding recreational activities and associated human impacts near lakes stocked with fish. October 28, 2003.

Glesne, Reed, NPS Biologist
Personal communication with Roy Zipp, 2003 (regarding tailed frogs); July 7 and 13, 2004 (regarding BMI impact thresholds)

Hoffman, Bob, Oregon State University
Personal communication July 30, 2003.
Personal communication. August 5, 2003.
Personal communication. October 14, 2003.

Holmes, Ronald, NPS Aquatic Ecologist
Personal communication. August 5, 2003.

Holsinger, PhD, John R., Professor of Biological Sciences, Old Dominion University
Personal communication regarding stygobromus, to Amy Hill. March 30, 2001.

Kennedy, Jesse, NPS
Personal communication regarding historic resources within the North Cascades National Park Service Complex. January 15, 2004.

Kuntz, Bob, NPS
Personnal communication with Kim Cornelisse, URS Corporation. June 25, 2004.

Larson, G., Oregon State University
Personal communication. May 21, 2003.

McKean, Sandy, Spokesperson, Hi-Lakers and Trail Blazers
Personal communication, July 17, 2003.

Mierendorf, Robert, NPS Archeologist.
Personal communication regarding archeological resources and sensitive trails and lakes within North Cascades National Park Service Complex. January 2004.
Personal communication regarding archeological sites within the North Cascades National Park Service Complex. January 8 and January 15, 2004.

Moran, Patrick, Toxicologist, USGS-Water Resources Division
Personal communication with Tom Campbell, URS Corporation. 2004.

Nielsen, Rob, URS
Personal communication with Nancy VanDyke, URS. January 16, 2004.

Ostberg, Carl, Fishery Biologist, Western Fisheries Research Center
Personal communication. August 4, 2003.

Ostberg, Carl, Fishery Biologist, Western Fisheries Research Center
Personal communication with Kim Cornelisse, URS Corporation. February 23, 2004.

Pfeifer, Bob, Fishery Biologist, Washington Department of Fish and Wildlife
Personal communication regarding fish impacts and thresholds, November 14, 2002 and July 7, 2004.
Personal communication with E. Bissell, TQ NEPA. January 5, 2004.
Personnal communication. May 12, 2004.

Reidel, Jon, North Cascades Geologist
Personal communication. August 1, 2003.

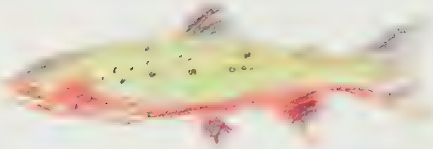
Rosenlund, Bruce, Fishery Biologist USFWS
Personal communication, September 2003 (Bruce is considered to be the expert on fish removal using antimycin based on work in the Rockies, including Rocky Mountain National Park. Bruce recommended methods of application, and assisted with estimating costs).

Stinson, Derek
Personal communication between D. Stinson, Washington Department of Fish and Wildlife and Kim Cornelisse, URS Corporation on June 28, 2004.

Zipp, Roy, North Cascades National ParkService Complex, NPS Biologist
Personal communication with Sandy McKean, spokesperson for Trail Blazers and Hi Lakers, July 17, 2003.
Observations made by North Cascades National Park Staff in summer 2003.
Personal communication with P. Steinholtz, URS Corporation. December 17, 2003.
Personal communication with K. Cornelisse, URS Corporation on December 19, 2003.
Personal communication regarding Draft Sport Fishing Use Estimates. December 27, 2003.
Personal communication with J. Switzer, NPS. December 31, 2003.
Personal communication regarding visitor use.

Zyskowski, Stan, NPS
Personal communication. August 15, 2003.

Canada
Mt. Baker Wilderness
Mt. Shuksan
North C
Nationa
(north
Baker Lake
Skagit River
Marblemount
Sauk River
Suiattle River
Darrington
Boulder River Wilderness
0
5
10
20



Glossary, Acronyms, and Index

North C
Nation
Nort

Glossary 491

Acronyms and Abbreviations 500

Index 502

GLOSSARY

Abiotic Factors — The nonliving physical and chemical aspects of an organism's environment. Abiotic refers to such factors as light, temperature, and topography.

Adaptive Management — A principle that incorporates monitoring and research into conservation actions. Specifically, it is the integration of planning, management, and monitoring to test assumptions in order to adapt and learn.

Adsorbed — The accumulation of gases, liquids, or solutes on the surface of a solid or liquid.

Algae — One-celled (phytoplankton) or multi-cellular plants either suspended in water (plankton) or attached to rocks and other substrates (periphyton). Algae are an essential part of the lake ecosystem and provide the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day because life cycles are short.

Alkalinity — A measure of the amount of carbonates, bicarbonates, and hydroxide present in water. Low alkalinity is the main indicator of susceptibility to acid rain; increased alkalinity is often related to increased algae productivity.

Alleles — Forms of a gene. One of two or more alternative forms of a gene, occupying the same position on paired chromosomes and controlling the same inherited characteristic.

Ammonia — The first form of nitrogen released when organic matter decays. It can be used by most aquatic plants and is, therefore, an important nutrient.

Amphipod — A small crustacean of the order Amphipoda, such as the sand flea, having a laterally compressed body with no carapace.

Anadromous — Migrating up rivers from the sea to spawn (reproduce) in fresh water.

Angler — A person who fishes with a rod and reel.

Anthropocentric — Those engaged in wilderness management have found it useful to characterize impacts to wilderness values according to two alternative philosophical perspectives on wilderness: anthropocentric and biocentric. The *anthropocentric* perspective emphasizes human use and enjoyment of wilderness.

Aquatic invertebrates — Aquatic animals without an internal skeletal structure such as insects, mollusks, and crayfish.

Bathymetry — The measurement of water depth at various places in a water body. The physical characteristics including depth, contour, and shape of the bottom of a body of water.

Benthic — Relating to or characteristic of the bottom of a sea, lake, or deep river. The benthic community is composed of a wide range of plants, animals, and bacteria from all levels of the food web.

Benthic Macroinvertebrate — Macroinvertebrates are large, generally soft-bodied organisms that lack backbones. Benthic macroinvertebrates live in or on the bottom sediment in aquatic environments.

Benthos — A group of organisms, most often invertebrates, that live in or on the bottom in aquatic habitats (such as clams that live in the sediments) which are typically immotile or of limited motility or range.

Bioaccumulation — The accumulation of a harmful substance, such as a heavy metal or an organochlorine, in a biological organism, especially one that forms part of the food chain.

Bioassay — A simple biological test that uses an indicator organism to measure the potency of a given substance in a biological system. An example of a bioassay would be a test that measures algal growth in response to different nutrient concentrations.

Biocentric — Those engaged in wilderness management have found it useful to characterize impacts to wilderness values according to two alternative philosophical perspectives on wilderness: anthropocentric and biocentric. The *biocentric* perspective emphasizes protection and maintenance of natural processes and conditions.

Biological Diversity — The variety of life on Earth. It generally refers to the variety of species within an ecosystem or community. The greater the diversity or variety there is in a system, the greater the strength and stability the system has over the long run; diversity strengthens the potential of a population to cope with, or respond to, changes in the environment.

Biological Integrity — Biological integrity refers to the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region.

Biomass — The total amount of living organisms (plants and animals) in a lake. Measured as organisms per cubic meter, biomass indicates the degree of a lake system's productivity.

Biota — The combined plant and animal life of a particular region.

Blue-Green Algae — Algae that are often associated with problem blooms in lakes. Some produce chemicals toxic to other organisms, including humans.

Broodstock — Animals or fish with a common origin that are kept for breeding; for example, the pool of captured adult salmon a hatchery has available for artificial spawning. This pool can be made up of wild and/or returning hatchery salmon.

Cilia — A microscopic hair-like process extending from the surface of a cell or one-celled organism.

Cyprinids — Freshwater fish of the family that includes carp and minnows, typically with rounded scales, soft fins, and toothless jaws.

Copepod — A type of crustacean zooplankton that exhibits a wide variety of feeding preferences, even consuming other zooplankton. The larger copepods are an important component of the food base for larger vertebrate organisms such as larval amphibians and fish.

Cirque — A steep bowl-shaped hollow occurring at the upper end of a mountain valley, especially one formed by the erosive activity of a glacier.

Crustacean Zooplankton — The animal form of plankton that has a segmented body, paired, jointed appendages, and a hard outer skeleton; one example is a copepod.

Deciduous — Trees that lose their leaves at the end of the growing season; also called hardwoods.

Desired Future Conditions — In this case, describes what the lake and lake environment should be like after implementation of the management actions contain in this plan/EIS. It summarizes the anticipated physical changes that would result from carrying out planned management actions. It is an expression of resource goals that have been set for a lake and lake environment and describes the lake as it would appear when the goals set for it have been achieved. It includes a description of physical and biological processes, the environmental setting, and the human experience.

Diaptomid copepod — A family of free-living largely planktonic copepods with very long first antennae.

Diatom — Any of various microscopic one-celled or colonial algae (planktonic) of the class Bacillariophyceae, having cell walls of silica consisting of two interlocking symmetrical valves.

Ecology — The study of the interrelationships between organisms and their environments.

Ecosystem — A community of living organisms interacting with one another and with their physical environment, such as a forest, pond, or estuary.

Ecotone — A zone of transition between two different ecosystems.

Endemic — Native to or confined to a certain region.

Endorheic Lakes — Lakes whose surface waters do not flow to the ocean. They are also called terminal or sink lakes. Their watersheds are often contained within a mountain range or other natural geologic feature that has severed their direct hydrologic connection to the ocean. Because their inflowing waters subsequently flow into dry watercourses or are evaporated, minerals and other inflow erosion products concentrate within these water bodies. With a continuing mineral input, some water bodies typically become saline compared to water bodies that drain to the oceans. Because evaporation plus seepage are the major water outflow pathway, endorheic water-bodies also tend to be more sensitive to pollutant inputs than water bodies that drain to the oceans.

EIS Environmental Impact Statement — The *National Environmental Policy Act of 1969* requires that an environmental impact statement be prepared to evaluate the potential environmental effects of major federal actions. An EIS identifies and analyzes activities that might affect the human and natural environment.

Ephemeral — Short-lived; existing or continuing for a short time only.

Escapement Goal — The number of adult fish desired to return to their spawning habitat in a lake, river, or stream in order to meet management objectives.

Eutrophic Lakes — Lakes that are high in nutrients and support a large biomass (all the plants and animals living in a lake). They are usually either weedy or subject to frequent algae blooms, or both. Eutrophic lakes often support large fish populations but are also susceptible to oxygen depletion.

Eutrophication — The process by which lakes and streams are enriched by nutrients and the resulting increase in plant and algae. The extent to which this process has occurred is reflected in a lake's trophic classification:

Oligotrophic – nutrient poor

Mesotrophic – moderately productive
Eutrophic – very productive and fertile

Evolutionarily Significant Unit (ESU) — A set of populations that is morphologically and genetically distinct from other similar populations and with a distinct evolutionary history. Recognized for purposes of Endangered Species Act protection.

Extirpated Species — A species that is no longer present in an area where it once lived. This could be the result of several environmental factors, including human activities.

Flocculent Bottom — The joining of small colloids (a particle-size range of less than 0.00024 millimeters) into a small group of soil particles and the deposition or settling out of the water of these small colloids onto the bottom of a lake.

Floodplain — Land adjacent to a river that is periodically subject to flooding.

Food Web — The hierarchy of organisms in a community according to the order of predation from one to another; usually, the lower members are the food source for members higher on the food web.

Fragmentation — The breaking up of large and continuous ecosystems, communities, and habitats into small, discontinuous areas that are surrounded by altered or disturbed lands or aquatic features.

Fyke Net — A fish trap shaped like a bag, cylinder, or cone mounted on rings, with funnels that direct fish into successive compartments; also called a wing net.

Genotype — The genetic makeup of an organism as opposed to its physical characteristics.

Geographic Connectivity — The concept that one location is close enough in proximity and without obstacles to allow genetic interchange by target organisms in that location with organisms in another location.

Goal — A concise statement that describes intended results or desired conditions and that are normally expressed in broad, general terms without a specific time frame for achievement. Goals are reached by attaining specific objectives, although not all goals have quantifiable objectives.

Gradient — Pertains to the upward or downward slope (the steepness) of such features as river or stream banks.

Graminoid — Grass-like plants, including grasses, sedges, rushes, reeds, and cattails.

Habitat — The location and the combination of biotic and abiotic surroundings that a particular kind or type of plant or animal occupies for part of its life cycle. It typically includes the substrate (soil, rocks, water), other nonliving features, vegetation, and often, other organisms.

Haplotype — A set of closely linked genes inherited as a unit. A contraction of the phrase "haploid genotype" (genotype is the genetic makeup of an organism). "Haplo" comes from the Greek word for "single."

Headwater Lakes or Streams — The water from which a river or lake originates; the source.

Historic Range — Those geographic areas a species was known or believed to occupy in the past.

Hybridization — Interbreeding that results in combining the genes of two different species or other taxa in the resulting generation of organisms (hybrids).

Indicator taxa; indicator species — A species capable of showing early signs of change if ecological conditions change. In the case of this plan/EIS, changes would occur to the ecology of mountain lakes in the study area.

Igneous — Rock formed by the cooling and consolidation of magma.

Indigenous — Living or occurring naturally in an area.

Interbreeding — The mating of related individuals; see also, hybridization.

Intermittent Streams or Lakes — Streams and lakes that only contain water seasonally, or at certain times of the year.

Introgressed — The incorporation of genes from one species into the gene pool of another species as a result of hybridization (crossbreeding).

Juvenile — Any organism that is not adult, for example, the life stage of salmon living in fresh water before entering the ocean, the life stage of a salamander or aquatic insect living in a lake.

Lateral Moraine — A pile of materials carried or pushed by a glacier and deposited along the side of a valley glacier.

Listed Species — A species, subspecies, or distinct vertebrate population segment that has been added to the federal lists of endangered and threatened wildlife and plants as they appear in section 17 of Title 50 of the Code of Federal Regulations (50 CFR 17.11 and 17.12)

Macrobenthos — A term that includes all invertebrates larger than one millimeter that are found in or on the floor of a body of water. This community of organisms is used extensively for environmental monitoring because benthos provide an essential link to fish and birds.

Macroinvertebrates — Aquatic invertebrate organisms that can be seen clearly with the naked eye.

Macrophytes — A macroscopic (large enough to be perceived or examined by the unaided eye) plant.

Meristically — Using physical characteristics to determine the degree of differentiation between two populations.

Metamorphosis — A change in the form and often habits of an animal during normal development after the embryonic stage. Metamorphosis typically includes transformation from one life form to another, such as from a maggot into an adult fly, a caterpillar into a butterfly, or a tadpole into a frog.

Metamorphosed (crystalline rocks) — Rock whose original minerals or textures, or both, have been transformed to new minerals and new textures by reactions in the solid state as a result of high temperature, high pressure, or both.

Metapopulation — Geographically separate populations of the same species that are connected by infrequent, but critical, interbreeding and genetic exchange with nearby populations.

Mitigation — Activities that can prevent, reduce, or compensate for adverse environmental impacts.

Moraine — Landforms composed of unsorted materials deposited by glaciers. They can cover broad geographic areas of millions of acres. Topography can vary from nearly level "till" plans to rough end moraine landscapes composed of steep dry ridges interspersed with deep kettle holes. These glacial "kettles" are frequent locations for lakes and wetlands.

Morphology — The three-dimensional characteristics or form of a feature such as a river channel or of an organism.

Native — A term used to describe an organism that occurs naturally in a specific area or habitat. No species of fish are native to the mountain lakes in the North Cascades Complex, though thy may be native to the surrounding basin (for example, the Ross Lake strain of rainbow trout stocked in Ridley Lake).

Natural Variation — The changes that occur naturally in an ecosystem (includes physical characteristics, plants, and animals) over time without human disturbance.

Neotenic Phase — Retention of juvenile characteristics in the adults of a species, as among certain amphibians; the attainment of sexual maturity by an organism still in its larval stage.

Nonmarket Value — Values associated with goods or services over and above their selling price.

Objective — A concise, time-specific statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used in achieving identified goals.

Oligotrophic Lakes — Lakes that are generally clear, deep, and fee of weeds or large algae blooms. Though beautiful, they are low in nutrients and do not support large fish populations. However, oligotrophic lakes often develop a food web capable of sustaining a very desirable fishery of large game fish.

Omnivores — Eating both animal and plant foods.

Oxidize — To combine with oxygen, or to change (a compound) by increasing the proportion of the electronegative part or change (an element or ion) from a lower to a higher positive valence: remove one or more electrons from (an atom, ion, or molecule).

Paleolimnological — The study of the organic and chemical history of lakes through analysis of bottom sediments. The study of conditions and processes in ancient lakes; interpretation of the conditions and accumulated sediments and the geomorphology and geologic history of ancient lake basins.

Pelagic — Open water.

Phenotype — The visible characteristic of an organism resulting from the interaction between its genetic makeup and the environment.

pH — The measure of the acidity or alkalinity of a solution (such as vinegar) or a damp substance (such as soil). The pH of pure water is 7, with lower numbers indicating acidity and higher numbers indicating alkalinity.

Phytoplankton — Photosynthetic plants that live in water. The phytoplankton community consists of a rich array of microscopic and submicroscopic organisms that include diatoms, blue-green algae, green algae, and photosynthetic flagellates.

Piscivorous — Mammals and birds that feed frequently or mainly on fish.

Piscicide — A chemical that is used to kill fish in a lake.

Plankton — A collective term for a variety of freshwater (and marine) organisms that live within the lighted zone or near the surface of the water. The density of plankton varies, depending on the availability of nutrients and the stability of the water. A liter of lake water may contain more than 500 million planktonic organisms.

Plate Tectonics — The theory of global tectonics that deals with the processes by which the lithosphere (outer 100 kilometers of the solid Earth) is moved laterally over the asthenosphere (the region of the earth that lies 100 to 350 kilometers below the surface where the rocks have little strength and are easily deformed).

Pleistocene Epoch — The period of geologic time between approximately 1.8 million years ago and 11.5 thousand years ago.

Potassium permanganate — A dark purple salt ($KMnO_4$) used as an oxidizer and disinfectant.

Prehistoric Conditions — Composition, structure, and functioning of ecosystems resulting from natural processes that, based on sound professional judgment, are believed to have been present prior to substantial human-related changes to the landscape.

Query — An inquiry or question.

Rainshadow Effect — A region of relatively low rainfall that occurs downwind of a mountain or mountain range. A rain shadow occurs when wind encounters a mountain and the air is forced upward; this rising air expands and cools. If it cools enough, clouds will form on the upwind side of the mountain and rain or snow will fall. In contrast, as the air descends the downwind side of the mountain, it is warmed by compression, and the clouds dissipate. This reoccurring dissipation causes the downwind side of the mountain to receive relatively less rainfall than the upwind side, and hence, forms a rain shadow.

Range — The geographic area a species is known or believed to occupy.

Reaches (Stream) — The stretch of water visible between bends in a river or channel.

Refugia — An area of relatively unaltered climate that is inhabited by plants and animals during a period of continental climatic change (as a glaciation) and remains as a center of relict forms from which a new dispersion and speciation may take place after climatic readjustment.

Riparian Vegetation — Vegetation found along waterways and shorelines that is adapted to moist growing conditions and occasional flooding.

Risk — The degree of vulnerability to factors detrimental to survival.

Rotifers — Tiny animalian mibrobes whose Latin name literally means "wheel bearer." The two wheels on the rotifers are made of cilia that beat and create a current that draws water-born food into their gut.

Salmonid — Fish within the family Salmonidae; includes salmon, trout, char, and whitefish.

Scoping Process — Early and open activities used to determine the scope and significance of a proposed action, what level of analysis is required, what data is needed, and what level of public participation is appropriate. Scoping focuses on the issues surrounding the proposed action and the range of actions, alternatives, and impacts to be considered in an environmental assessment or an EIS.

Sedimentation — Accumulated organic and inorganic matter on the lake bottom. Sediment includes decaying algae and weeds, marl (mixture of clay and lime), and solid and organic matter eroded from the lake's watershed.

Self-sustaining — For this plan/EIS, refers to reproducing fish that are able to maintain populations over time without further stocking.

Smolt — A young anadromous salmonid migrating downstream that has undergone the physiological changes necessary to survive in salt water.

Spawn — The deposition and fertilization of eggs by organisms such as salmon and trout.

Species — A group of individual plants or animals (including subspecies and populations) that have common characteristics and interbreed among themselves and not with other similar groups.

Species of Concern — Refers to those species that might be in need of concentrated conservation actions, which can vary depending on the health of the populations and degree and types of threats. At one extreme, there may only need to be periodic monitoring of populations and threats to the species and its habitat. At the other extreme, a species may need to be listed as a federal threatened or endangered species. Species of concern receive no legal protection, and the use of the term does not necessarily mean that the species will eventually be proposed for listing as a threatened or endangered species.

Substrate — The nonliving material or base upon which plants or animals live or grow.

Synergy/Synergistic — The combined effect or effort is greater than parts; the working together of two or more elements, especially when the result is greater than the sum of their individual effects.

Talus — A sloping mass of rock debris at the base of a cliff.

Tarn — A small mountain lake, especially one formed by the action of glaciers.

Taxon (plural taxa) — Category of organisms. Any of the groups to which organisms are assigned according to the principles of taxonomy, including species, genus, family, order, class, and phylum.

Tectonic — The branch of geology relating to the continuing structural evolution of the earth's crust (for example, the formation of mountains and valleys).

Tectonic Uplift — The geological conditions produced by movements in the earth's crust that elevate rocks, forming mountains.

Total Kjeldahl Nitrogen — A combined measurement of ammonia and organic nitrogen. It can be considered a surrogate measure of overall lake productivity.

Trophic Levels — The various positions of a food web that are occupied by specific organisms (see "Food Web" above).

Turbid/Turbidity — Visible undissolved solid material suspended in water. Increasing the turbidity of the water decreases the amount of light that can penetrate.

Ubiquitous — Being or seeming to be everywhere at the same time; omnipresent.

Untrammeled — Not limited or restricted by human activities.

Unmetamorphosed Sedimentary Rocks — Sedimentary rocks that have not yet undergone metamorphic conditions.

Watershed — The area drained by a river system. It includes the whole region or extent of country that contributes to the supply of a river or lake; the natural boundary of a basin.

Wetland — Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, wet meadows, and similar areas.

Zooplankton — Microscopic or barely visible animals that eat algae (the animal form of plankton). Freshwater zooplankton found in high mountain lakes would include microscopic animals such as protozoans, rotifers, copepods, and cladocerans. Zooplankton are an important component of the lake food web and ecosystem. For many fish, they are the primary food source.

ACRONYMS AND ABBREVIATIONS

BMI	benthic macroinvertebrate
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CUA	Commercial Use Authorization
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESU	Evoluntionarily Significant Unit
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DM	Department Manual
GIS	Geographic Information System
GPS	Global Positioning System
IOC	Index of Connectivity
km	kilogram
mg	milligram
ml	milliliter
MOU	memorandum of understanding
NEPA	*National Environmental Policy Act*
NHPA	*National Historic Preservation Act*
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRA	national recreation area
OSU	Oregon State University
PCB	polychlorinated biphehyl

pH	potential of hydrogen
PL	Public Law
POP	persistent organic pollutants
SEPA	State Environmental Policy Act
SHPO	State Historic Preservation Office or Officer
SR	State Route
TAC	Technical Advisory Committee
TCP	Tradition Cultural Property
TKN	total Kjeldahl nitrogen
USFWS	United States Fish and Wildlife Service
USC	United States Code
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WDFW	Washington Department of Fish and Wildlife
WPWA	*Washington Park Wilderness Act of 1988*

INDEX

adaptive management, x, xi, xiii, xvi, xix, xx, xxiii, xxv, xxxiii–xxxvi, 49, 53, 64, 65, 68, 76, 82–85, 89, 98, 102, 106, 110, 120, 121, 123, 124, 127, 129, 137–140, 143, 144, 238, 244, 261, 267, 272, 280, 286, 289, 295, 309, 315, 329, 331, 342, 343, 344, 347, 349, 361, 363, 375, 381, 394– 397, 399, 405, 407–413, 415–417, 420, 422, 428, 430, 435, 437, 442, 447, 448, 450–452

Antimycin, xi, xii, xxvi, xxvii, 28, 84, 86, 89, 91–96, 130, 131, 219, 265, 266, 267, 271, 273, 275, 276, 287, 288, 290, 292, 311, 312, 314, 319, 324, 361, 376, 418, 421, 423, 424, 435, 438–440, 442, 443, 448, 452

Azure Lake, xvii, 57, 66

Battalion Lake, xvii, 57, 66, 68, 77, 88, 104, 190, 252, 303, 312, 317, 346, 440, 443

Bear Lake, xvii, 57, 63, 66, 68, 88, 104, 185, 299, 309, 315, 321, 440, 443

Berdeen Lake, xvii, 57, 63, 66, 68, 77, 88, 104, 252, 440, 443

Berdeen Lake, Lower, xvii, 57, 63, 66, 68, 77, 88, 252, 440, 443

Berdeen Lake, Upper, xvii, 57, 63, 66, 68, 88, 252, 440, 443

biological integrity, iv, v, vii, ix, xiii, 3, 5, 50–53, 56, 74, 76, 84, 98, 101, 102, 109, 115, 120–122, 143, 237, 369, 395, 405, 409, 437, 447, 448, 450

Blum (Largest/Middle, No. 3), xvii, 57, 63, 66, 68, 77, 88, 104, 252, 440, 443

Blum (Lower/West, No. 4), xvii, 57, 63, 66, 68, 77, 88, 252, 440, 443

Blum (Small/North, No. 2), xvii, 57, 63, 66

Blum (Vista/Northwest, No. 1), xvii, 57, 63, 66

Bouck Lake, Lower, xvii, 57, 63, 66, 68, 88, 104, 440, 443

Bouck Lake, Upper, xvii, 57, 63, 66, 68, 97, 104

Bowan Lake, xvii, 57, 66, 68, 97, 104

bull trout, xv, xxviii, 25, 26, 41, 48, 50, 54, 55, 132, 171–175, 184, 191, 303–305, 308, 312, 315, 318, 320, 322, 324

chemical, x–xii, xv, xxiii, xxv–xxvii, xxix–xxxi, xxxvi, 17, 40, 50, 53–55, 80, 86, 88, 89, 91, 92, 94, 98, 120, 121, 127, 129–131, 133—135, 140, 144, 154, 162, 219, 247, 250, 265–267, 271, 272, 275, 276, 287, 288, 290–293, 311, 312, 314, 316, 319, 324, 330–334, 343, 344, 347–349, 361, 362, 367, 376, 379, 384, 387, 388, 406, 414, 421–424, 439, 442

Congress/Congressional, vii, viii, xv, xx, 10, 12–14, 30, 32, 33, 38, 73–75, 80, 82, 100, 106, 108, 112, 113, 124, 215, 217, 218, 229, 392, 393, 394, 396, 398, 399

Coon Lake, xvii, 56, 57, 66, 68, 97, 104, 177, 181, 207, 208, 211, 228, 231, 302, 311, 316, 372, 376, 379, 382, 384, 385, 427, 429

Copper Lake, xviii, 58, 63, 66–68, 71, 97, 104, 105, 176, 220

Dagger Lake, xvii, 58, 66, 68, 88, 104, 187, 189, 207, 302, 311, 312, 317, 440, 443

Dee Dee Lake, Upper, xvii, 58, 63, 66, 68, 77, 88, 104, 207, 252, 440, 443

Dee Dee/Tamarack Lake, Lower, xvii, 58, 66, 68, 97

Despair Lake, Lower, xvii, 58, 66

Despair Lake, Upper, xvii, 58, 66

Diobsud Lake No. 1, xvii, 58, 63, 66, 68, 88, 169, 252, 378, 440, 443

Diobsud Lake No. 2, Lower, xvii, 58, 63, 66, 68, 77, 88, 104, 252, 440, 443

Diobsud Lake No. 3, Upper, xvii, 58, 66, 69, 97, 104, 252

Doubtful Lake, xvii, 58, 66, 69, 77, 88, 104, 373, 378, 440, 443

Doug's Tarn, xvii, 14, 58, 66, 69, 88, 104, 252

East Lake, Lower, xvii, 58, 66

East Lake, Upper, xvii, 58, 66, 165

education, x, 5, 34, 80, 84, 229, 230, 341, 358, 359, 361, 377, 418, 438, 441, 442, 444, 446

enabling legislation, iv, vi–viii, xv, 4, 5, 11, 14, 33, 34, 73–75, 82, 100, 108, 112, 229, 241, 251, 281, 298, 327, 339, 356, 392– 394, 396, 434

Firn Lake, xvii, 58, 66, 69, 77, 88, 104, 312, 443

food web, 16, 21, 22, 24, 25, 157, 158, 160, 161, 162, 167, 245, 253–255, 262, 269

Green Bench Lake, xvii, 59, 66

Green Lake, xvii, 59, 66, 69, 77, 88, 104, 189, 220, 440, 443

Hanging Lake, xvii, 59, 66, 69, 77, 88, 252, 440, 443

Hidden Lake Tarn, xvii, 59, 63, 66, 69, 78, 97, 104

Hidden Lake, xvii, 59, 63, 66, 69, 77, 88, 97, 104, 176, 211, 372, 373, 376, 379, 382, 385, 443

Hi-Laker, vi, xxiii, 11, 14, 48, 80, 127, 214, 215, 392

Hi-Yu Lake, xvii, 59, 66, 69, 97, 104

Hozomeen Lake, xvii, xxviii, xxix, 55, 59, 63, 66, 69, 77, 88, 104, 110, 132, 133, 147, 155, 164, 175, 191, 193, 194, 207, 211, 302, 304, 306, 308, 311–313, 315, 317–320, 323, 324, 372, 376, 379, 382, 385, 440, 443

impairment, xxv–xxxii, 31, 33, 129–136, 237, 241, 242, 251, 254, 256, 257, 259, 261–264, 267, 269–271, 273–275, 277, 281, 284–286, 289, 291–294, 297, 309, 315, 320, 324, 327, 329, 331, 333, 334, 339, 341, 344, 348, 349, 356, 360, 363, 364, 366, 369, 402, 448

Index of Connectivity/IOC, 248, 250, 252, 256, 257, 263, 270

Ipsoot Lake, xvii, 59, 66, 69, 88, 175, 443

Jeanita Lake, xvii, 59, 66, 69, 78, 88, 104, 443

Kettling Lake, xvii, 59, 66, 69, 77, 88, 252, 302, 310, 311, 317

Kwahnesum Lake, xvii, 59, 66, 69, 97, 104

long-toed salamander, 16, 21–23, 25, 48, 55–57, 155, 161, 165, 167–169, 246, 248, 249, 250, 256, 257, 263, 270

management action, iii, iv, vii, ix, x, xiii, xiv, xvi–xviii, xx, xxvii, xxxii–xxxvi, 3, 26–29, 43, 49, 51, 52, 54–57, 63–67, 73, 75, 82–85, 89, 94, 97–99, 101, 102, 106, 107, 109, 112, 124, 131, 136–140, 147, 170, 179, 201, 202, 229, 238, 239, 244, 251, 253, 256, 259, 262, 266, 269, 272, 273, 275, 278, 279, 285, 288, 290, 291, 293–295, 320, 326, 336, 356, 357, 361, 368, 372, 373, 376–379, 381, 382, 384, 386, 388, 390–399, 401, 402, 406, 408, 409, 410, 412–414, 416–418, 420, 422–424, 434, 436, 439–446, 448, 449, 452

McAlester Lake, xvii, xxviii, 59, 66, 69, 88, 104, 132, 180, 189, 199, 207, 252, 257, 302, 306, 308, 311, 313, 317, 318, 338, 346, 372, 440, 443

mechanical, x, xi, xxiii, xxv, xxvii, xxix–xxxi, 80, 86, 88, 89, 98, 120, 121, 127, 129, 131, 133, 134, 135, 144, 264, 265, 267, 271, 272, 275, 276, 287, 288, 290–293, 330, 331, 332, 333, 334, 343, 344, 347, 349, 361, 362, 379, 384, 387, 388, 406, 414, 421

Middle Lake, Lower, xvii, 59, 66

Middle Lake, Upper, xvii, 59, 66

Monogram Lake, xvii, 59, 60, 63, 66, 69, 77, 88, 97, 104, 180, 211, 372, 376, 379, 382, 385, 440, 443

Monogram Tarn, xvii, 60, 63, 66, 69, 97

Nert Lake, xvii, 60, 66, 69, 97, 104, 190, 303, 312, 317, 322

No Name Lake, xviii, 60, 67, 69, 97, 104

Noisy Creek Lake, Upper, xviii, 60, 67

Northwestern salamander, 21, 25, 48, 165, 168, 169, 170, 188, 246, 248, 249, 256, 257, 263, 270

Oregon State University/OSU, v, vii, ix, 4, 13, 15, 16, 18, 19, 22, 23, 50, 51, 52, 53, 54, 87, 155, 213, 302, 311

Panther Potholes, Lower, xviii, 60, 67, 69, 97, 104

Panther Potholes, Upper, xviii, 60, 67

Pegasus Lake, xviii, 60, 67

piscicide, xxvi, 86, 89, 92, 94–96, 130, 219, 265, 267, 272, 276, 287, 290, 292, 361, 376, 387, 406, 414, 421, 423, 424, 438, 440, 442, 443, 448, 452

Pond SE of Kettling Lakes, xviii, 60, 67, 70, 97, 104

Quill Lake, Lower, xviii, 60, 63, 67, 70, 97, 104

Quill Lake, Upper, xviii, 60, 63, 67, 70, 97, 104

Rainbow Lake, xviii, xxi, 60, 63, 67, 70, 77, 88, 89, 97, 104, 105, 125, 151, 172, 175, 177, 192, 207, 228 372, 427, 440, 443

Rainbow Lake, Upper (North), xviii, 60, 63, 67

Rainbow Lake, Upper (South), xviii, 60, 63, 67, 70, 97, 105, 207

Rainbow Lake, Upper (West), xviii, 60, 63, 67, 70, 97, 104, 207

Redoubt Lake, xviii, 60, 67, 165

Reveille Lake, Lower, xviii, 61, 67

Reveille Lake, Upper, xviii, 61, 67

Ridley Lake, xviii, 55, 61, 63, 67, 70, 76, 97, 105, 155, 170, 177, 207, 211, 302, 311, 313, 317, 319, 323, 372, 376, 379, 382, 385

riparian, xv, 26, 32, 180, 182, 185–187, 189, 194, 195, 197–199, 217, 218, 259, 301, 324, 330, 336–338, 340–344, 346–349

Rotenone, 40, 91, 219

Sky Lake, xviii, 61, 67, 440, 443

Skymo Lake, xviii, 61, 67, 70, 77, 88, 105, 220

Sourdough Lake, xviii, 61, 67, 70, 77, 88, 105, 175, 252, 304, 312, 318, 440, 443

Sourpuss Lake, xviii, 61, 67

Stiletto Lake, xviii, 61, 67, 70, 97, 105, 152, 153, 252

Stout Lake, xviii, 61, 67, 70, 77, 79, 88, 105, 176, 443

Stout, Lake Lower, xviii, 61, 67, 70, 88, 105, 443

Sweet Pea Lake, xviii, 61, 67, 70, 97, 105

Talus Tarn, xviii, 61, 67

Tapto Lake, Lower, xviii, 61, 67

Tapto Lake, Middle, xviii, 61, 67

Tapto Lake, Upper, xviii, 61, 67

Tapto Lake, West, xviii, 62, 67

Thornton Lake, Lower, xviii, 62, 67, 70, 77, 88, 105, 211, 443

Thornton Lake, Middle, xviii, 62, 67, 70, 97, 105, 211

threatened/endangered/sensitive species, xii, xv, xxix–xxxi, 16, 22, 26, 29, 36, 41, 50, 55, 89, 92, 93, 120, 133–135, 160, 164, 165, 169, 170, 181, 183, 186, 187, 190–192, 194, 197, 200, 202, 246, 255, 256, 265, 266, 271, 275, 287, 294, 299, 306, 307, 309, 310, 313, 315, 316, 319, 321, 323–326, 329–334, 336, 338, 340, 343, 344, 346–349, 357, 358, 360, 363–367, 450

Thunder Lake, xviii, 62, 67, 150–153, 170, 174, 180, 181, 191, 211, 302, 311

Tiny Lake, xviii, 62, 67

Torment Lake, xviii, 62, 67, 70, 97, 105

total Kjeldahl nitrogen/TKN, 16, 17, 22, 23, 51, 53, 155, 162, 163, 167, 246, 248, 250, 252, 256, 257, 263

Trail Blazer, vi, xxii, xxiii, 8, 11, 13–15, 48, 54, 80, 126, 127, 214, 215, 392

Trapper Lake, xviii, 62, 67, 70, 88, 105, 190, 303, 312, 317, 373, 443

Triplet Lake, Lower, xviii, 62, 63, 67, 70, 89, 105, 252, 440, 443

Triplet Lake, Upper, xviii, 62, 63, 67, 70, 89, 105, 440, 443

Triumph Lake, xviii, 62, 67, 70, 97, 105, 176

U.S. Geological Survey/USGS, v, 4, 15–19, 22, 23, 118, 185, 220

Unnamed Lake (FP-01-01), xviii, 62, 67

Unnamed Lake (MR-11-01), xviii, 62, 67, 71, 97, 105, 207

Unnamed Lake (MR-16-01), xviii, 62, 67, 71, 89, 105, 271

Vulcan Lake, xviii, 62, 67

wetland, 182, 189, 195, 199, 326, 330, 332, 340

Wilcox/Lillie Lake, Upper, xviii, 62, 63, 67, 71, 77, 89, 90, 265, 377, 439, 440, 443

Wilcox/Sandie Lake, Lower, xviii, 63, 67, 71, 77, 89, 105, 252, 440, 443

Wild Lake, xviii, 63, 67, 192

wilderness, iv, vii, viii, xv, xxxiii–xxxvi, 6, 15, 27, 36, 38–41, 48, 73–76, 78, 89, 101, 102, 109, 112, 113, 119–121, 137–140, 148, 149, 151, 204 –206, 212, 213, 215–218, 224, 225, 230, 284, 341, 366, 375, 377, 380, 381, 383, 386, 387, 390, 392, 393, 399, 401–417

Willow Lake, xviii, 55, 63, 67, 71, 97, 105, 170, 176, 179, 187, 190, 199, 207, 208, 211, 299, 302, 303, 309, 311–313, 316, 317, 319, 321, 323, 372, 376, 379, 382, 385

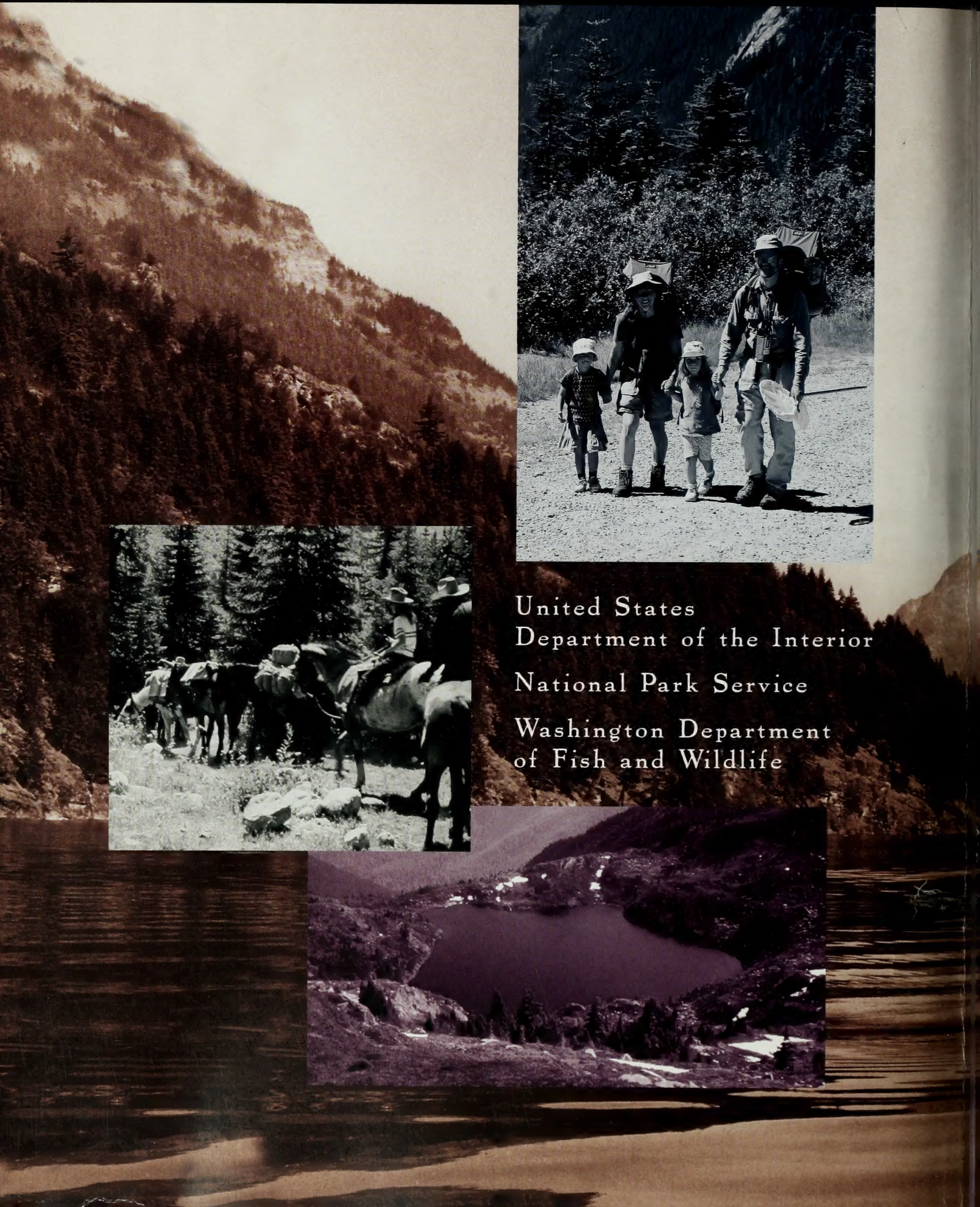
The National Park Service extends its appreciation to Roy Zipp, North Cascades National Park Service Complex; Bob Pheifer, Washington Department of Fish and Wildlife; and Mike Swayne and Pat Buller, Trail Blazers, Inc., for all the wonderful photos in this document and to Roy Reynolds, RED, Inc. Communications for the beautiful illustrations.

March 3, 1849

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-272 (May 2005)

National Park Service
U.S. Department of the Interior



United States
Department of the Interior

National Park Service

Washington Department
of Fish and Wildlife